DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

NSW Wildlife and Conservation Bushfire Recovery

Medium-term response plan

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Cover photo: Post-fire regrowth, Torrington State Conservation Area. John Spencer/DPIE

Acknowledgement of Country

We acknowledge the traditional custodians of Country and pay our respects to Elders past, present and emerging. The land management of earlier generations, including the Elders, who have fought for their rights in the management of our natural environment are valued and respected. We acknowledge the grief of Aboriginal people in response to the recent fires, and recognise that the actions we take today impact on the natural environment, and we commit to collaborating with Aboriginal people who continue to hold the knowledge of our traditional custodians to improve the way we manage our natural environment now and into the future.

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Environment, Energy and Science
Department of Planning, Industry and Environment
4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
Phone: +61 2 9995 5000 (switchboard)
Phone: 1300 361 967 (Environment, Energy and Science enquiries)
TTY users: phone 133 677, then ask for 1300 361 967
Speak and listen users: phone 1300 555 727, then ask for 1300 361 967
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

Report pollution and environmental incidents
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Minister’s foreword

Matthew Kean, Minister for Energy and Environment

The 2019–20 bushfires were some of the worst in Australia’s recorded history, burning at a scale never seen before.

In the immediate aftermath of the fires, we moved quickly to maximise the survival chances of affected species – deploying food supplements and water, collecting and banking seeds, supporting wildlife carers and suppressing threats from feral animals. We also kicked off crucial survey and monitoring work, to help focus our longer-term recovery efforts once the initial emergency response subsided. The full suite of actions we undertook during this period were set out in the NSW Government’s *Wildlife and Conservation Bushfire Recovery, Immediate Response*, released in January 2020.

Eleven months on, the Australian bush is showing a remarkable capacity to recover. Green shoots have started to appear on the blackened ground and on trees scarred by the bushfires. Native animals are beginning to return to the fire grounds. Our knowledge and understanding of the impacts of the fires is evolving as we assess burnt areas and survey fire-affected plants and animals. And we have had some really pleasing surprises, with species like the smoky mouse surviving despite 90% of its habitat being burnt.

It’s now time to move to the next phase.

The *NSW Wildlife and Conservation Bushfire Recovery Medium-term Response Plan* explains what the NSW Government will do over the next five years to help our biodiversity recover. The plan incorporates the best available advice from experts in the field, sets new priorities for action and identifies those species and ecosystems most in need of our help. It provides the latest understanding and builds on previously published research and analyses. It also reports back on the tremendous amount of work done since January 2020 as part of our immediate response, and supports the recommendations arising from the NSW Bushfire Inquiry – particularly those relating to wildlife, conservation and Aboriginal land management.

Looking beyond the medium term, we know that bushfires are likely to become more frequent and severe. Importantly, the actions in this plan will help build the skills, knowledge and systems that governments, landholders, wildlife carers and scientists will need to meet the longer-term conservation challenges we face.

I want to pay tribute to all the people who worked so hard during the fire season. Staff from the National Parks and Wildlife Service played an admirable role on the front line and behind the scenes, fighting 519 fires and investing a combined 43,000 staff days on firegrounds across New South Wales. They are now working with staff from across the Department of Planning, Industry and Environment to help our native species recover. I want to recognise the community volunteers who put in so much of their own time, rescuing animals during the fires and nurturing them back to health for a safe return to the wild. I also acknowledge and thank the Australian Government for their ongoing funding support for wildlife and habitat recovery.

The recovery process will continue for many years and we all have a part to play. This plan will keep our efforts focused. As our knowledge increases and new information comes to light, we will adjust our priorities and refine our responses, ensuring we continue to make progress and get the best possible conservation outcomes.

With shared commitment, hard work and dedication, we can recover.

A note on the contribution of communities

Communities responded to the bushfires through action and donated significant amounts of money towards wildlife rescue and rehabilitation. The campaign led by the Port Macquarie Koala Hospital raised over $7.9 million to July 2020, and by May 2020 an estimated $80 million had been donated to wildlife rescue and care groups.

Corporate and community sponsors including Woolworths, Foodbank and the World Wide Fund for Nature (WWF) donated substantial food resources for wildlife through the *Saving our Species* (SoS) partnership program as part of immediate post-fire emergency food supplementation.

The community also volunteered its time, with many groups and individuals engaging in wildlife recovery after the bushfires, building on a strong tradition of care, concern and community support for wildlife in New South Wales. In the volunteer wildlife rehabilitation sector, volunteers contributed well over 17,000 person days from August 2019 to February 2020, a contribution valued at more than $4.7 million (NPWS 2020). From July 2019 to the end of April 2020, volunteers contributed more than 220,000 hours supporting conservation programs managed by the NSW Department of Planning, Industry and Environment.

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1. Introduction

Immediately following the 2019–20 bushfires, the NSW Government released the *Wildlife and Conservation Bushfire Recovery, Immediate Response January 2020* (the immediate response) to support wildlife and conservation recovery (DPIE 2020a).

The Government's efforts focused on mapping the extent of the fire damage, identifying at-risk species and communities, supplying emergency food, water and shelter to wildlife, controlling feral animals to reduce pressure on native wildlife, collecting and banking seeds, and supporting wildlife carers.

While critically important, the NSW Government's immediate response was just the first step in an ongoing recovery process. Biodiversity in New South Wales is still experiencing the impacts of the bushfires even as the next bushfire season begins. Many species and communities will take years to recover, particularly those not adapted to fire or impacted by prolonged drought or other threatening processes.

This medium-term response plan outlines steps the NSW Government will take over the next 1–5 years to support the recovery of biodiversity in New South Wales. The Department of Planning, Industry and Environment (DPIE) is responsible for implementation of the plan, which will be integrated into the long-term management of key risks to biodiversity. The plan will also help New South Wales build its adaptive capacity and resilience in a changing climate – where increased risk from bushfire will be just one of many threats.

In developing the plan, the NSW Government sought advice from members of the NSW Threatened Species Scientific Committee (TSSC) and the Biodiversity Conservation Advisory Panel (BCAP). The plan also draws on broader recommendations made by the Commonwealth Wildlife and Threatened Species Bushfire Recovery Expert Panel and the National Environmental Science Program Threatened Species Recovery (TSR) Hub. Additionally, DPIE convened expert roundtables in February 2020 which included scientific experts and key Aboriginal knowledge holders, and has considered information from other experts and jurisdictions.

The findings and recommendations of the NSW Bushfire Inquiry, and the Royal Commission into National Natural Disaster Arrangements, have been considered and incorporated as appropriate.

The Plan is supported by two supplements:

- *NSW Wildlife and Conservation Bushfire Recovery Supplement 1 – Assessing the impact of the bushfires on wildlife and conservation* (Supplement 1) provides the latest information on the impact of the fires on wildlife and conservation in New South Wales
- *NSW Wildlife and Conservation Bushfire Recovery Supplement 2 – Report on the Immediate Response January 2020* (Supplement 2) provides an update on the progress of the immediate recovery actions announced by the NSW Government in January 2020.

2. Bushfire impacts on wildlife and conservation

Over the course of 2020, the NSW and Commonwealth Governments undertook detailed monitoring and assessments to better understand the impact of the bushfires on wildlife and conservation. A detailed overview of that work and its findings is contained in Supplement 1.

Figure 1 illustrates the extent and severity of the fires. A summary of key impacts is provided in Figure 2.

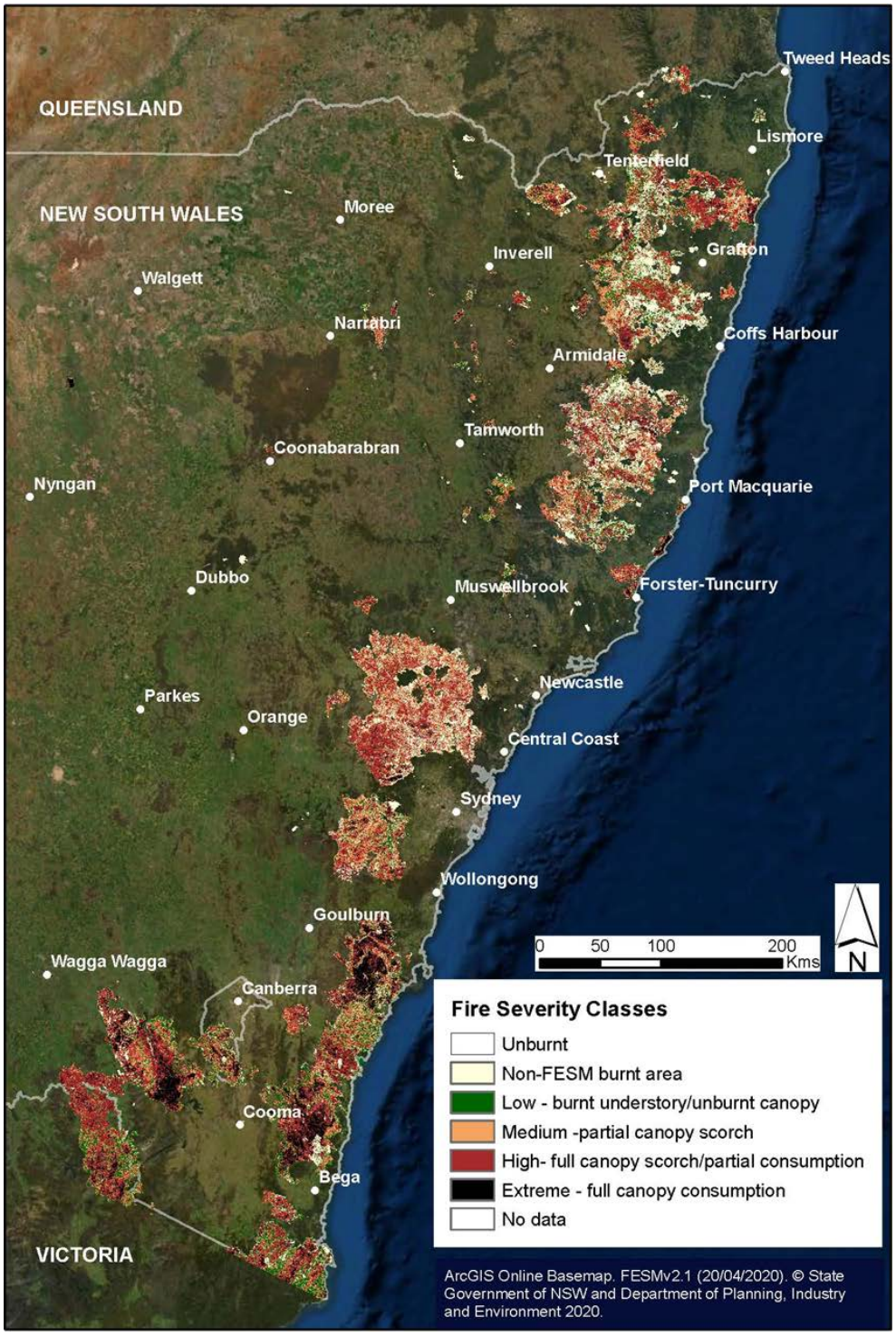

Figure 1 Fire extent and severity map of New South Wales, April 2020

Figure 2 **Key facts about the impacts of the 2019–20 fires in New South Wales**
Source: *NSW Fire and the Environment 2019–20 Summary* (DPIE 2020e).

Fire impacts on koalas

Appendix A provides the NSW Koala Strategy: Bushfire Recovery Actions, the NSW Government's response to the impacts of the 2019–20 bushfires on koalas. The actions were informed by a workshop in early February 2020 led by the NSW Koala Strategy Independent Expert Panel, involving representatives from community groups, non-government organisations, research organisations and from across government.

There are some immediate actions being taken to support the rescue and care of koalas injured in the 2019–20 bushfires. Other actions address short- and medium-term issues generated by the fires to ensure the successful delivery of the NSW Koala Strategy. Actions at all levels will be implemented collaboratively with DPIE's strategic partners across government and the NSW community.

Photo: Koala. A Marshall/DPIE

3. The medium-term bushfire recovery plan

The NSW Government's approach to bushfire recovery recognises and addresses the need to consider many interacting pressures on species and ecosystems, including drought, climate change and the impacts of pests and weeds. This plan is focussed on improving species' and ecosystems' resilience to these threats over the long term.

Themes and aims and their strategies and actions

The medium-term bushfire recovery plan is based around eight themes and four aims and a suite of strategies and supporting actions for the themes.

Themes and aims

The themes and aims were derived from the advice and recommendations of experts consulted by the NSW Government (see section 1 for information about these experts).

The themes and aims are set out in Table 1 below. They are widely applicable and will be used to inform broader land management and conservation activities, including responses to future bushfire events.

Table 1 Themes and aims for medium-term bushfire recovery

Themes	
1	**Prioritisation and planning** of recovery actions should be based on robust post-fire assessments and expert knowledge, and occur at multiple scales (species, population, community, site and landscape).
2	**Improving our knowledge and management of fire** is essential, drawing on best available science and Aboriginal knowledge.
3	Bushfire recovery should take a holistic **landscape-scale approach** that considers all the pressures on species and ecological communities and complements species-focused programs.
4	**Ecological refuge areas** should be identified and protected for the long term.
5	There are circumstances where natural recovery processes should be supplemented with **more intensive interventions**, such as habitat restoration and augmentation, ex situ (off-site) management including seed banking and captive breeding for future reintroduction, genetic rescue, translocation and feral-proof enclosures.
6	Well-structured, long-term **ecological monitoring** is necessary to inform adaptive management and cost-effective responses to conservation challenges such as managing bushfire risk.
7	**Communication with the community** on understanding fire, recovery progress and how they can contribute is an essential part of the recovery process.
8	**Social, economic and environmental costs and benefits** need to be considered in all bushfire recovery and response actions.

Aims
Improve the trajectories of at-risk and threatened species and ecological communities.
Prevent the loss of key populations of threatened species and ecological communities by mitigating threats in the post-fire environment.
Wherever possible, facilitate the **natural recovery** of plants, animals and ecological communities by mitigating the impact of fire and other threats.
Promote **landscape and ecosystem health** in bushfire recovery recognising the multiple benefits that healthy landscapes provide.

Strategies and actions

A suite of strategies and supporting actions will be deployed to operationalise each of the eight themes, as summarised in Table 2 and detailed in subsequent sections. The exception is Theme 8 (Consideration of social, economic and environmental costs and benefits), which is a cross-cutting theme and informs the design and implementation of all the plan's actions.

Collectively, the themes, strategies and actions support the four aims outlined in Table 1.

Table 2 NSW Wildlife and Conservation Bushfire Recovery: Medium-term response plan

Theme	Strategy	Action	
1. Planning and setting priorities for on-ground actions	**1.1 Ongoing assessment of priority species at the state scale**	1.1.1	Continue to assess the impacts of the 2019–20 fires and act on national and state priorities for species and ecological community recovery, focusing on fire-sensitive species and species in areas subject to high fire frequencies
		1.1.2	Conduct field inspections to determine threats to recovery for priority species (including impacts by pests, weeds and other land uses)
		1.1.3	Undertake emergency ex situ conservation measures
	1.2 *Saving our Species* (SoS) fire impact assessments	1.2.1	Assess and regularly update fire impacts on all SoS sites, species and communities
		1.2.2	Develop and implement tailored response plans for SoS sites, species and communities facing the most significant fire impacts
	1.3 Review the conservation status of species and communities	1.3.1	TSSC to review the conservation status of fire affected species and ecological communities under the *NSW Biodiversity Conservation Act 2016*
	1.4 Modelling and mapping to protect World Heritage values	1.4.1	Use spatial modelling and assessment to identify and protect World Heritage values from fire and other threats
	1.5 Build capacity for future fire responses	1.5.1	Support the wildlife rescue and rehabilitation sector, fire combat agencies and veterinarians to build their capacity to access and assist wildlife during bushfire response and recovery (commenced as part of the Immediate Response)
		1.5.2	Use lessons learned from the 2019–20 bushfires to inform planning and preparedness for future fire responses

Theme	Strategy	Action	
2. Improving our knowledge and management of fire	**2.1 New and better targeted research**	2.1.1	Research ways to improve fire management strategies and reduce the risks that bushfires pose to people, property and the environment through the Bushfire Risk Management Research Hub
		2.1.2	Develop fire response research projects and deliver through the SoS program
	2.2 NPWS fire management	2.2.1	Employ 125 new NPWS firefighters to help protect ecological assets through rapid response to bushfires and remote area firefighting
		2.2.2	Incorporate updated information and mapping of environmental assets and cultural values in reviews of NPWS reserve fire management strategies
		2.2.3	Amend the *National Parks and Wildlife Act 1974* to provide for the declaration of national park assets of exceptional ecological and cultural significance and introduce regulations that allow NPWS to prescribe fire management actions that protect those assets
		2.2.4	Work with the Rural Fire Service to ensure ecological risk is embedded in a new risk management framework for fire management in NSW
	2.3 Aboriginal cultural fire management	2.3.1	Collaborate with Aboriginal communities to measure the contribution of cultural fire management to biodiversity conservation, community safety and risk, and address barriers to cultural fire management programs
	2.4 Managing fire impacts under NPWS Aboriginal joint management agreements	2.4.1	Work with Aboriginal communities to protect and manage fire affected sites on the national park estate
3. Taking a landscape-scale approach	**3.1 NPWS feral animal and weed control (commenced as part of the Immediate Response)**	3.1.1	Extend post-fire aerial baiting and shooting programs on the national park estate, incorporating SoS actions and complementing feral animal and weed control operations on private land undertaken by Local Land Services
		3.1.2	Extend post-fire weed control on the national park estate and undertake other targeted weed control to support recovering landscapes and complement threatened species activities delivered through SoS

Theme	Strategy	Action	
	3.2 Actions and investment to improve post-fire water quality	3.2.1	Provide support and tools to land managers to help them predict post-fire erosion risk, assess the impact of different rainfall events on water catchments and make decisions to improve water quality in areas impacted by the fires
		3.2.2	Support local councils implementing post-fire actions through the Bushfire affected coastal waterways grants
4. Protecting ecological refuge areas	**4.1 Identifying refuges**	4.1.1	Build comprehensive maps of potential ecological refuge areas, linked to biological data and fire science
		4.1.2	Identify habitat refuges for koalas across land tenures to optimise recovery actions and inform where to permanently protect koala habitat
	4.2 Protecting refuges	4.2.1	Integrate refuge maps into fire, pest and weed planning to set priorities for management actions
		4.2.2	Implement adaptation measures to protect critical climate change refugia, such as actions identified in the 'Gondwana Rainforest of Australia World Heritage Adaptation Plan'
5. More intensive interventions	**5.1 Expanding conservation fencing to protect recovering ecosystems**	5.1.1	Expand temporary conservation fencing in fire affected areas to protect species vulnerable to predation, grazing or trampling, and recovering ecosystems
		5.1.2	Assist fire impacted private landowners, through the Biodiversity Conservation Trust, to protect recovering vegetation from grazing, including through fencing
	5.2 Breeding, propagation and reintroduction programs	5.2.1	New and expanded breeding and propagation programs for priority threatened species including the brush-tailed rock-wallaby, smoky mouse, Wollemi pine and rainforest plants (commenced as part of the Immediate Response)
		5.2.2	Continue the NSW captive breeding program for threatened species not covered by current Commonwealth funding including the regent honeyeater, eastern bristlebird and frog and turtle species
		5.2.3	Collected animals, where not released back into the wild, used to establish insurance populations in captivity (commenced as part of the Immediate Response)
	5.3 Augmenting habitats	5.3.1	Continue to research the best way to replace tree hollows that are damaged or destroyed during bushfires or removed when land is cleared

Theme	Strategy	Action
6. Ecological monitoring, evaluation and reporting	**6.1 Deliver robust monitoring, evaluation and reporting**	6.1.1 Use the Biodiversity Indicator Program to measure and report on post-fire recovery of biodiversity and ecological health and the long-term impacts of fire, climate change and hydrological regimes 6.1.2 Report on specific bushfire recovery actions through current monitoring, evaluation and reporting programs including site-based monitoring
7. Communication with the community	**7.1 SEED Citizen Science Digital Hub**	7.1.1 Report to the community on progress of bushfire recovery and new research findings 7.1.2 A new SEED Citizen Science Digital Hub is connecting community volunteers, sharing data from citizen science projects and helping people to find and sign up to conservation projects across New South Wales, and learn new skills
8. Social, economic and environmental costs and benefits	**8.1 Social, economic and environmental costs and benefits to be considered in all bushfire recovery and response actions**	Applies to all actions

Theme 1: Planning and setting priorities for on-ground action

The scale of the 2019–20 fires means that careful prioritisation and planning of recovery actions is essential. Drawing on current knowledge, experience from past fires, on-ground observations and data collection, DPIE is developing an understanding of:

- how species and communities have been impacted
- how they might respond without intervention
- what kinds of interventions could improve their recovery
- where the priorities for action lie.

Cost and feasibility have also been considered to determine the most efficient and effective course of action. DPIE is applying a risk-based approach and developing preventative and mitigative controls such as in situ conservation actions (pest and weed control) and ex situ conservation activities (such as seed collection, storage and translocation), according to the relative risk each species faces.

On-ground actions are being delivered through DPIE programs such as SoS, through ongoing NPWS operational management of the national park estate, and with support from Environmental Trust grants. The recovery of threatened species not currently managed under SoS, or outside the national park estate, is being aided by landscape-scale action, such as fire management and aerial shooting and baiting of feral pests undertaken by other NSW Government agencies, including Local Land Services (LLS).

DPIE is also working with non-government conservation partners such as WWF, Birdlife Australia, universities and landholders, as well as other federal and state government bodies such as LLS, the Department of Primary Industries (Fisheries), Taronga Conservation Society and the Australian Museum in their efforts to conserve species and communities impacted by fire. As well as setting priorities at the species level, management responses have been recommended by DPIE scientists for all 26 NSW threatened ecological communities impacted by fire. These responses include:

- ground surveys
- fire exclusion and protection of soils from disturbance
- feral animal and weed control
- protection of burnt and unburnt areas from future fires.

Signs of hope for the greater glider

Rapid post-fire fauna surveys have found that the greater glider, Australia's largest gliding mammal, is persisting in both unburnt and burnt patches of forest.

Three greater glider populations are listed as endangered under the BC Act. Given the greater glider's high dependence on large, hollow bearing trees, it was feared the 2019–20 fires may have had a big impact on the species.

A post-fire spotlighting survey, conducted in Mt Kaputar in May 2020, found 77 greater gliders across four sites. The animals were absent from the middle of large, severely burnt patches, suggesting they are recolonising burnt forest from unburnt refuges. The number of greater gliders found suggests that the population in Mt Kaputar is healthy and, barring frequent landscape-scale fires, secure. Further work is needed to understand how they have fared in other burnt forests in eastern New South Wales.

The results demonstrate the importance of unburnt refuges, which are critical to conserving species and enabling them to repopulate burnt habitat post-fire.

These positive findings are not exclusive to the greater glider. Other species seen during monitoring have included many on both the NSW and Commonwealth governments' priority lists for urgent management intervention, including potoroos, spotted-tailed quoll, rufous scrub-bird, powerful owl, Parma wallaby and threatened microbats.

Photo: Greater glider. P Spark

Strategy 1.1 Ongoing assessment of priority species at state scale

Action 1.1.1: Continue to assess the impacts of the 2019–20 fires and act on national and state priorities for species and ecological community recovery, focusing on fire-sensitive species and species in areas subject to high fire frequencies

The impacts of the 2019–20 fires on the extinction risk of plant and animal species will continue to be assessed against the multiple hazards they face, including the effects of feral animals, weeds, pathogens, drought, inappropriate fire regimes (particularly too frequent fire), and changing climate regimes.

Where recovery actions for state and national priority species and communities are relevant to the national park estate, NPWS will include them in operational planning processes, fire and pest management programs, and general bushfire recovery programs. Where relevant, these activities will support the recovery of World Heritage values in fire affected World Heritage areas.

Action 1.1.2: Conduct field inspections to determine threats to recovery for priority species (including impacts by pests, weeds and other land uses)

Action 1.1.3: Undertake emergency ex situ conservation measures

As part of ongoing SoS and NPWS operations, field inspections are being conducted to determine impacts and threats to recovery for priority species, with a focus on fire-sensitive species and species (such as obligate seeders and rainforest species) located in areas subject to high fire frequencies. Where possible field inspections will also consider:

- populations within and adjacent to the broader fire boundary to assess the scale of fire-related impacts and post-fire recovery
- threats to post-fire recovery including impacts by feral herbivores, weeds, pathogens, inappropriate fire regimes and other disturbances
- emergency ex situ conservation measures (including germplasm collection) as required, with partner agencies including the Royal Botanic Gardens
- impacts from other land uses.

Strategy 1.2 Saving our Species fire impact assessments

Action 1.2.1: Assess and regularly update fire impacts on all SoS sites, species and communities

SoS is working with experts, land managers and conservation organisations to protect SoS sites, species and communities on public and private land. SoS is systematically assessing listed threatened species and ecological communities, considering fire impacts, the predicted response of the species to fire and the predicted impact on its viability. On-ground or aerial assessments are being used to verify the predicted impacts and are being updated as new information becomes available.

Action 1.2.2: Develop and implement tailored response plans for SoS sites, species and communities facing the most significant fire impacts

A range of actions are being taken based on these assessments, and to respond to the opportunity for additional Commonwealth funding to support post-fire recovery. Actions include:

- developing response plans for fire affected species and incorporating them into species conservation strategies for each species under the BC Act
- amending species conservation strategies to recognise fire as a major threat
- developing new conservation projects and actions, with a focus on monitoring and creating insurance populations.

As of 1 December 2020:

- over 360 species and ecological communities have been assessed as impacted by the fire
- almost 200 species and communities had on-ground or aerial assessments
- more than 170 fire response plans have been developed outlining the priorities for threatened species and communities post-fire
- over 200 species and communities were responded to during the immediate response at over 330 sites with over 470 post-fire conservation actions adapted or implemented
- Eight conservation strategies have had major changes approved
- 34 species and communities have had new projects or actions funded by the Commonwealth to support post-fire recovery
- surveys of data poor and fire affected reserves have been conducted.

Strategy 1.3 Review the conservation status of species and communities

Action 1.3.1: TSSC to review the conservation status of fire affected species and ecological communities under the NSW *Biodiversity Conservation Act 2016*

The scope and severity of the fires' impact on biodiversity in NSW has prompted the TSSC to review the conservation status of some impacted species and ecological communities. The TSSC has undertaken a preliminary assessment to set priorities for the review, which could lead to upgrading species to a higher risk category, creating new listings of threatened species or threatened ecological communities, or confirming that current listings are appropriate.

The NSW TSSC is working with the Commonwealth to determine priority species for reassessment, noting that the national threat status of a species under the Commonwealth EPBC Act may need to be changed, particularly for species endemic to New South Wales. New South Wales is also working with the Commonwealth and other states through the Threatened Species and Ecological Communities Working Group to implement the Common Assessment Method, ensuring a consistent national approach to conservation status.

Strategy 1.4 Modelling and mapping to protect World Heritage values

Action 1.4.1: Use spatial modelling and assessment to identify and protect World Heritage values from fire and other threats

Fire affected two World Heritage areas in New South Wales: 71% of the Greater Blue Mountains Area World Heritage area and 54% of the Gondwana Rainforests of Australia World Heritage area.

The severity of the fires varied across both areas. In the Greater Blue Mountains, the fires burnt large areas of dry eucalypt forest, which are adapted to recover after fire, but also sensitive swamp, basalt and shale forest communities which are now at high risk. In the Gondwana Rainforests, the burnt areas included fire-sensitive rainforest ecosystems. These impacts were reported to the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in April 2020 (DAWE 2020a, 2020b).

Managing these areas to avoid future impacts from fires and other threats is a priority. DPIE is using spatial modelling and assessment to identify the risks to World Heritage values from the fires and the compounding threats after the fires. Modelling and mapping will cover:

- vegetation communities most likely to contain World Heritage values
- priority threatened species and ecological communities impacted by the fires
- burnt areas with significant fire impacts on World Heritage values
- unburnt areas that serve as an initial refuge for World Heritage values and species
- other threatening processes that could be compounded by impacts of fire.

This assessment will inform where to direct management actions to support the recovery and resilience of World Heritage values. It will also support national park planning processes; for example, by identifying where weed and pest control may benefit World Heritage values, where fire management strategies may need review, and where specific monitoring of World Heritage values is needed.

Strategy 1.5 Build capacity for future fire responses

Action 1.5.1: Support the wildlife rescue and rehabilitation sector, fire combat agencies and veterinarians, to build their capacity to access and assist wildlife during bushfire response and recovery (commenced as part of the Immediate Response)

Note: This action responds to recommendation 53 of the NSW independent expert inquiry into the 2019–20 bushfire season

The scale of the 2019–20 fires tested the capacity of government and non-government organisations to respond to impacts on wildlife and conservation. Many lessons have been learned, and it's important these are recorded so they can inform future planning and capacity building.

Supplement 2 outlines the support the Government is providing to the wildlife rescue and rehabilitation sector, fire combat agencies and vets, to build their capacity to access and assist wildlife during bushfire response and recovery. This commenced during the bushfire emergency and is ongoing.

Action 1.5.2: Use lessons learned from the 2019–20 bushfires to inform planning and preparedness for future fire responses

Within DPIE, the lessons learned from the 2019–20 bushfires are being documented so they can be built into planning and management systems and improve preparedness for future fire events.

Impacts of fire on Gondwana Rainforest World Heritage values

The Gondwana Rainforests of Australia (Gondwana Rainforests) is a World Heritage area in north-east New South Wales and south-east Queensland, containing the remnants of the once vast rainforests that covered Australia when the climate was cooler and wetter. The Gondwana Rainforests contain a diversity of vegetation communities with varying degrees of fire tolerance. The 2019–20 fires affected 16 of the 28 reserves in the NSW section of the Gondwana Rainforests with variable severity.

Rainforests are particularly sensitive to fire. To better understand the extent and impacts of the 2019–20 fires, NPWS used aerial survey to double-check and refine the statewide remote sensing analysis. Field assessments were also carried out to understand the impacts on the World Heritage values, particularly impacts on fire-sensitive rainforest ecosystems and threatened species.

The results of the assessments show that some rainforest areas were less fire-affected than previously understood, including in Mount Nothofagus and Washpool national parks. However, other areas, such as the dry rainforests in Oxley Wild Rivers National Park, were significantly impacted, with the loss of some rainforest patches.

The assessments have provided further information on fire recovery response and resilience in plants, especially rainforest and wet sclerophyll species. In New England National Park, some areas of cool temperate rainforest that were burnt at low to medium severity showed canopy death, demonstrating that some types of rainforest can be impacted even at low fire intensities. Some positive signs of recovery were seen, including basal growth, coppicing, new shoots and seedling regeneration.

Photo: Gondwana Rainforest. R Cleary/DPIE

Fourteen flora response surveys were conducted on rainforest and wet sclerophyll forests in the northern parks in the World Heritage area, with very positive results in terms of seedling recruitment and reshooting post-fire.

Animal surveys are showing signs of recovery. Several rare and threatened species, including the Hastings River mouse, rufous scrub-bird, stuttering barred frogs, long nosed potoroo, red legged pademelon and threatened bats have been found post-fire in burnt areas. There have also been encouraging signs of recovery for greater gliders and powerful, sooty and masked owls.

Under suitable environmental conditions and given enough time and management, there are indications that impacted rainforests may recover. The greatest challenge will be protecting these areas from further fire to allow regeneration to occur. Considering the time scale, significant multi-generational commitment will be required to achieve this outcome.

Citizen Science supports bushfire recovery

Citizen science is scientific work undertaken by members of the general public, often in collaboration with professional scientists and scientific institutions. Citizen science projects help to meaningfully engage the community in conservation work and can contribute robust data for long-term ecosystem and land management monitoring, modelling, forecasting, research and evaluation.

In the wake of the 2019–20 fires, the NSW Government is supporting citizen science projects that contribute to bushfire recovery by providing funding and technical expertise.

Bush After Fire

Developed by the Atlas of Living Australia and the Bushfire Risk Management Research Hub, and run in association with DPIE, the ‘Bush After Fire’ project commenced in February 2020.

Participants can submit photos and descriptions of areas of burnt bush via a mobile app, with observations used to validate fire severity maps and understand how ecological communities recover after fire. Information about burn severity provided through structured surveys allows DPIE scientists to test fire mapping, interpret plant responses and assess changes to animal habitats.

NSW Community Wildlife Survey

The NSW Community Wildlife Survey was released in 2019 and aims to improve our understanding of the distribution of koalas and other wildlife in New South Wales. The data is used to indicate how populations of wildlife have changed over time, and to investigate what might be causing that change.

The survey is being used to gather information about where wildlife was affected by fire and where populations remain within and near the fire grounds. It will also help to determine priority sites for action as part of the NSW Koala Strategy.

Theme 2: Improving our knowledge and management of fire

The 2019–20 fires provide an opportunity to increase our knowledge of the impacts of fire and how to manage them. The impacts that fires have on wildlife and conservation values are determined by the attributes of the fire – frequency, seasonality, severity, extent, type (above or below ground) – as well as the fire history of the landscape, and the fire regimes to which flora and fauna are adapted (NPWS 2004).

Many species are adapted to particular patterns of recurrent fire, with some native plants dependent on fire to complete their life cycles. However, there can be negative impacts if fires are too intense or too frequent, or if they occur in combination with other threats such as feral predators, herbivores and weeds, land-clearing, logging or climate change.

The behaviour of fire in the landscape is also influenced by many natural and human factors, such as weather, climate, land use, vegetation and previous fires. To understand and improve the recovery of wildlife and conservation values from this fire season, and to conserve these assets into the future:

- the first step is to draw on existing knowledge to understand how the 2019–20 fires are interacting with other threats, and to better manage these threats
- the second step is to identify the range of fire regimes that will achieve the objectives of protecting human life and property but also maintain biodiversity
- the third and final step is to undertake on-ground management of fire - both through hazard reduction programs, and ecological and cultural fire management - to achieve the optimal mix of fire regimes to achieve both objectives. Across Australia, capacity in this area is growing but incomplete. It remains an ongoing research priority, with its importance identified in the Final Report of the NSW Bushfire Inquiry.

Current knowledge and management of fire in New South Wales is increasingly informed by traditional knowledge and practices. For many thousands of years Aboriginal people have used and shared cultural fire management to influence the landscape. Aboriginal people recognise that fire is a tool that helps produce food and warmth but also creates healthy and functioning ecosystems for other species. The knowledge and practice of Aboriginal cultural fire management is being revitalised, providing an opportunity for current and future generations to learn new skills, develop capacity and build respect for the environment, culture and heritage.

Strategy 2.2 NPWS fire management

Action 2.2.1: Employ 125 new NPWS firefighters to help protect ecological assets through rapid response to bushfires and remote area firefighting.

Note: This action responds to recommendations 20, 21 and 45 of the NSW independent expert inquiry into the 2019–20 bushfire season.

As part of the response to the NSW Bushfire Inquiry, the NSW Government has funded 125 new NPWS firefighters and an additional helicopter for fire management and response operations. The new NPWS firefighters will assist in protecting ecological assets through rapid aerial response to bushfires and remote area firefighting. The funding will mean an increase in up to 80 remote area firefighters, a 20% increase for these teams, consistent with recommendations from the NSW Bushfire Inquiry. The funding will also support increased hazard reduction activity in high risk areas close to property.

Action 2.2.2: Incorporate updated information and mapping of environmental assets and cultural values in reviews of NPWS reserve fire management strategies

Note: This action responds to recommendation 19 of the NSW independent expert inquiry into the 2019–20 bushfire season.

NPWS has a comprehensive set of fire management policies and procedures to guide and direct its approach to managing fires in our national parks and reserves. Individual reserve fire management strategies describe how fire will be managed at a park and reserve level. Reviews of reserve fire management strategies following significant fire events consider changes in bush fire risk and conservation of environmental values.

NSW has an effective framework for multi-agency bushfire management and planning. Bushfire risk management plans are developed by local bush fire management committees across NSW to help identify risks and responses for key assets in an area, including culturally and environmentally significant assets across different land tenures. NPWS will continue to work with NSW RFS to develop and improve spatial risk models that consider environmental assets and cultural values.

Action 2.2.3: Amend the *National Parks and Wildlife Act 1974* to provide for the declaration of national park assets of exceptional ecological and cultural significance and introduce regulations that allow NPWS to prescribe fire management actions that protect those assets

Note: This action responds to recommendation 19 of the NSW independent expert inquiry into the 2019–20 bushfire season.

In addition to new investment in NPWS fire management and response capabilities, historic amendments will also be made to the *National Parks and Wildlife Act 1974* to enable the declaration of assets of exceptional ecological and cultural significance – like the Wollemi Pine, and introduce regulations that allow NPWS to prescribe fire management actions that protect those assets.

These amendments will be supported by the establishment of a special NPWS ecological risk management team ($5.9 million over five years), which will identify the most significant ecological and cultural assets in the national park estate. The new NPWS team will work closely with the Rural Fire Service to ensure ecological risk is embedded in a new risk management framework for fire management in NSW.

Action 2.2.4: Work with the Rural Fire Service to ensure ecological risk is embedded in a new risk management framework for fire management in NSW

Note: This action responds to recommendation 19 of the NSW independent expert inquiry into the 2019–20 bushfire season.

Strategy 2.1 New and better-targeted research

Action 2.1.1: Research ways to improve fire management strategies and reduce the risks that bushfires pose to people, property and the environment through the Bushfire Risk Management Research Hub

Note: This action responds to recommendation 36 of the NSW independent expert inquiry into the 2019–20 bushfire season.

To improve our understanding and management of bushfires, DPIE is funding the NSW Bushfire Risk Management Research Hub (the Hub) to research ways to improve fire management strategies and reduce the risks that bushfires pose to people, property and the environment.

Established in 2018, and led by the University of Wollongong, the Hub brings together a team of fire management agencies, public land managers, and academic experts from the University of Wollongong, Western Sydney University, University of New South Wales, and the University of Tasmania.

The Hub has six major projects aimed at developing the knowledge needed to underpin cost-effective bushfire risk management strategies:

- dynamic mapping and analysis of past, present and future fire regimes in New South Wales
- fuel, flammability and carbon dynamics
- emissions and air quality

- fire regime thresholds of potential concern for threatened biodiversity
- health and social benefits of Indigenous fire management
- optimisation of cost-effective fire management.

The Hub conducted a series of research projects for the NSW independent expert inquiry into the 2019–20 bushfire season. These included:

- estimation of risk to threatened plant species and ecosystems caused by the severity of the 2019–20 bushfires and fire frequency
- impact of high fire frequency on plant species and vegetation communities – case study species
- impact of extreme fire severity on plant species and vegetation communities – case study species.

Beyond the inquiry, the Hub's research will continue to:

- develop a new database of plant species fire response traits
- characterise the sensitivities of plants (focusing on threatened species) to key components of the fire regime
- model the response of threatened species and communities to alternative fire management scenarios
- estimate thresholds of concern in fire regimes to inform fire management for the conservation of threatened plant species
- develop FireTools Cloud, a platform that incorporates geographical, biophysical and climate data to inform real-time, predictive fire behaviour modelling
- optimise cost-effective fire management to balance multiple objectives based on past, present and future knowledge of fire regimes and human influences.

Environment, Energy and Science knowledge acquisition

Action 2.1.2: Develop fire response research projects and deliver through the SoS program

Note: This action responds to recommendation 36 of the NSW independent expert inquiry into the 2019–20 bushfire season.

Bushfire-related research will be a strong focus for Environment, Energy and Science in the coming years.

Some of the research projects to be considered include:

- assessing the exposure of threatened plants to adverse fire impacts: frequency and season of burn
- defining fire regime thresholds of potential concern for critically endangered ecological communities
- using analysis of species sensitivity to fire, climate change and other disturbances to inform strategic state-wide management of key threatening processes and identify ex situ conservation options
- collaborating with Aboriginal communities to better understand management needs of native plants, animals and ecosystems
- assessing the feasibility of actions to help high conservation value ecosystems adapt to changing climatic conditions.

DPIE scientists are also carrying out research on fire regimes and impacts, and are involved in studying the impacts of the 2019–20 fires on a wide range of animals and plants to ensure as much as possible is learned from the fires, and that these species are conserved and better protected in the future.

Strategy 2.3 Aboriginal cultural fire management

Action 2.3.1: Collaborate with Aboriginal communities to measure the contribution of cultural fire management to biodiversity conservation, community safety and risk, and address barriers to cultural fire management programs

Note: These actions respond to recommendations 25 and 26 of the NSW independent expert inquiry into the 2019–20 bushfire season.

Fire management is a cultural practice that is integral to Aboriginal land management strategies to care for Country (Robinson et al. 2016). Aboriginal people's deep cultural knowledge about when different Country needs to be burned will contribute to evidence of the role of cultural fire management in biodiversity conservation. DPIE works with Aboriginal people and communities to facilitate Aboriginal cultural fire management on the national park estate.

The potential bushfire mitigation and conservation benefits of cultural fire management have not been well-documented, and more work needs to be done to understand them. DPIE will contribute to the DRNSW and Aboriginal Affairs NSW commitment to explore governance options for cultural fire management and build an evidence base through well-documented practices, outcomes and cost–benefit analysis.

Over the next 12 months, DPIE will collaborate with Aboriginal communities to:

- measure the contribution of cultural fire management to biodiversity conservation, community safety and risk
- measure wellbeing as it relates to connection to Country
- develop and publish an evidence base on the conservation benefits of cultural fire management
- address barriers that prevent cultural fire management programs.

Culturally appropriate engagement with Aboriginal communities will share knowledge and practise 'right-way' science to facilitate two-way cross-cultural learning (Camp et. al. 2020).

Strategy 2.4 Managing fire impacts under NPWS Aboriginal joint management agreements

Action 2.4.1: Work with Aboriginal communities to protect and manage fire affected sites on the national park estate

Aboriginal joint management is an arrangement between NPWS and traditional owners to share responsibility for the management of national parks, reserves and other areas. There are currently 33 Aboriginal joint management agreements in place in New South Wales, covering 2.2 million of the 7.2 million hectares in the NSW national park estate. The 2019–20 fires affected 12 areas covered by Aboriginal joint management agreements. NPWS has supported seven communities to carry out post-fire surveys to assess the impacts on Aboriginal cultural heritage.

Assessing fire impacts to cultural values in Biamanga National Park

Jointly managed by Aboriginal people and NPWS, Biamanga National Park is a wild landscape of cascades and granite boulders, ribbon gums and gurgling creeks, gorges and natural springs, not far from the Tasman Sea on the south coast of New South Wales. The park features Mumbulla Mountain, named after respected elder Jack Mumbler. It also contains an important area of unmodified coastal foothill habitat.

Sacred to the local Yuin People for millennia, in May 2006, Biamanga was returned to the traditional custodians as part of a joint management agreement with NPWS. Biamanga is a ceremonial meeting place for Yuin men and the landscape continues to connect Aboriginal people, culture and lore.

Between December 2019 and February 2020, bushfires burnt through about 84%, or 11,400 hectares of the park. The fires burnt at varying intensity, with some areas more severely impacted than others.

Following the 2019–20 fires, NPWS conducted a statewide program of assessment of fire effects on Aboriginal cultural heritage places and values located within the national parks. To determine the impacts on cultural sites within Biamanga National Park, NPWS commissioned archaeological and heritage consultants, along with Bega Local Aboriginal Land Council (LALC) and Merriman's LALC, to conduct field assessments and report on fire effects on previously recorded Aboriginal heritage within areas of the park.

The on-ground assessment was able to identify most of the previously recorded Aboriginal cultural heritage sites within the Biamanga Aboriginal Place, and found that fire impacts to sites were minor, and limited to superficial or cosmetic effects. The assessment also found that some previously unrecorded sites had been revealed, where the fires had reduced the surrounding vegetation. A full report on the survey's findings is being prepared for NPWS, the recommendations from which will inform the joint management and recovery actions for these significant sites.

Photo: Rocky gorge, Biamanga National Park. J Spencer/DPIE

Theme 3: Taking a landscape-scale approach

Intact and functional landscapes provide habitat for species that have large home ranges (see Broome 2001; Claridge at al. 2005), are sparsely distributed or are highly mobile or nomadic (see Garnett & Crowley 2000; Geering 2004; Geering 2006).

For these species to recover from bushfires, and persist in the longer term, they need access to healthy habitat that is connected across the landscape, not just in discrete places. A landscape-scale approach complements the species-by-species approach for broadly distributed species, and helps to meet other community objectives for healthy landscapes, such as maintaining water supply and quality.

Species and communities face a range of landscape-scale threats that can increase their risk of extinction, such as habitat loss and fragmentation caused by clearing and development. Recovery goals and actions need to take account of all these long-term drivers of change and focus on building healthy landscapes that will be resilient to threats in the future.

The widespread nature of the 2019–20 bushfires compounded these risks by reducing the availability of food, water and shelter, increasing exposure to feral predators and future fire events, and reducing connectivity. Conserving these species and communities relies on threats being managed at the landscape scale, and that requires cooperation between all public and private land managers.

Strategy 3.1 NPWS feral animal and weed control (commenced as part of the Immediate Response)

Action 3.1.1: Extend post-fire aerial baiting and shooting programs on the national park estate, incorporating SoS actions and complementing feral animal and weed control operations on private land undertaken by Local Land Services (commenced as part of the Immediate Response)

Action 3.1.2: Extend post-fire weed control on the national park estate and undertake other targeted weed control to support recovering landscapes and complement threatened species activities delivered through SoS (commenced as part of the Immediate Response)

As described in Supplement 2, landscape-scale pest and weed management actions were commenced as part of the NSW Government's immediate response to the bushfires. Actions 3.1.1 and 3.1.2 extend that program of action to restore habitat and increase connectivity.

The Great Western Wildlife Corridor

The Great Western Wildlife Corridor links the southern Blue Mountains World Heritage Area with Morton National Park and the conservation reserves of the southern escarpment forests. It is a priority management area under the SoS program for the koala and glossy-black cockatoo, and connects habitat across the landscape for many other threatened species, including the regent honeyeater, scarlet robin, flame robin and *Pomaderris cotoneaster*.

The NSW Government recently created the 3358-hectare Guula Ngurra National Park, near Bowral, for its important koala habitat, recognising the role this corridor plays in koala conservation. This new national park provides a link with existing smaller conservation reserves in the corridor, joining parts of Bangadilly National Park with parts of Wollondilly River Nature Reserve.

Up to 90% of mapped koala habitat in the Wingecarribee Shire escaped the 2019–20 fires, including the site of the new Guula Ngurra National Park, and high-quality habitats in the eastern water catchments. These habitats are now of increased importance as refuges, providing habitat and connectivity to the koala population in the Southern Highlands – the largest known population of koalas in southern New South Wales.

Priority actions for this corridor include:

- NPWS fire management actions to prevent spread of fire into the unburnt area
- NPWS feral animal and weed control
- incorporating koala habitat conservation into local fire planning and management
- continuing conservation actions and monitoring for all active SoS projects in the corridor
- implementing the Biodiversity Conservation Trust's Southern Highlands Koala Habitat Tender, which offers landholders annual payments for conserving native vegetation, including high value koala habitat.

Strategy 3.2 Actions and investment to improve post-fire water quality

Action 3.2.1: Provide support and tools to land managers to help them predict post-fire erosion risk, assess the impact of different rainfall events on water catchments and make decisions to improve water quality in areas impacted by the fires

After the 2019–20 bushfires had passed, rainfall in burnt areas had the potential to rapidly degrade waterways by eroding exposed soil and washing in ash and charcoal. This post-bushfire runoff reduces water quality by increasing the levels of nutrients, trace metals, suspended solids and organic matter, which can lead to fish kills or algal blooms (EPA 2020) and loss of habitat for platypus, frogs and turtles.

Reduced water quality can impact the health of sensitive estuarine ecosystems, which in turn affects local industries such as tourism, fishing and oyster-farming. To address the post-fire risk to water quality, DPIE scientists rapidly conducted and coordinated a number of activities:

- an initial risk assessment to identify estuaries with high risk of water quality impacts
- water quality surveys in affected waterways

- modelling and mapping of water quality risks
- installing water quality sensors
- providing advice and expertise to local government and stakeholders to help them understand water quality management
- developing longer-term plans to gather further data and address water quality management needs.

In early January 2020, DPIE produced a powerful state-wide model to predict the risk of hillslope erosion following the fires. This event-based model is one of a number of tools that land managers can use to assist erosion risk assessment and support land and water decision-making in areas impacted by the fires, including water catchments.

The hillslope erosion dataset was made publicly available on SEED and shared with other government agencies and local councils. In the Warragamba Catchment, managed by Water NSW and NPWS, the model was applied to areas where native vegetation and groundcover had been destroyed. Water NSW used the map to:

- identify the highest erosion risk sub-catchments and prioritise monitoring points and areas for erosion interventions
- communicate with stakeholders and regulators about the impacts of the bushfires and the risk to water quality
- inform modelling of the impact of different rainfall events on catchment water quality.

Action 3.2.2: Support local councils implementing post-fire actions through the *Bushfire affected coastal waterways grants*

In January 2020, the NSW Government also launched a grants program for bushfire affected waterways. The funding was provided to allow councils to act quickly to mitigate water quality impacts in coastal waterways.

On 1 May 2020, the NSW Government announced that $5 million in funding would be distributed across six councils – Bega Valley Shire Council, Eurobodalla Shire Council, Shoalhaven City Council, Mid-Coast Council, Port Macquarie-Hastings Council and Richmond Valley Shire Council (DPIE 2020b). Funded works include installation of sediment and erosion controls, bank stabilisation, riparian corridor management, water quality monitoring, and habitat restoration including weed control and revegetation. These projects are being coordinated and delivered by councils with technical support from regional water, floodplain and coastal management experts in DPIE.

Catchment management in fire impacted estuaries on the NSW south coast

Shoalhaven, Eurobodalla and Bega Valley councils have collectively received almost $3.7 million in grant funding from the NSW Government's Bushfire affected coastal waterways grants program to manage the impacts of the recent bushfires on sensitive estuarine ecosystems on the NSW south coast.

Fifty-two of the south coast estuary catchments between Nowra and the Victorian border were impacted by fire. After the fires, councils installed erosion and sediment controls such as coir logs in areas where there was significant disturbance. These controls have helped to catch sediment and ash before it entered waterways and estuaries.

Along with technical support from DPIE, the councils have access to a range of DPIE products and tools, including bushfire intensity mapping and high-resolution aerial photography to help them prioritise further post-fire recovery work, including further erosion and sediment controls, foreshore and riparian restoration, bush regeneration, and weed control and quality monitoring.

The councils will also be developing a joint South East Catchment and Waterways Fire Recovery Plan to help guide medium- to long-term works to manage the threats to environmental, cultural, social and economic values of catchments and waterways. This will involve other state government agencies, NPWS, LLS, DPI (Fisheries and Marine Parks) and Forestry Corporation NSW to ensure a coordinated response across all land tenures.

Photo: Burnt areas surrounding Wonboyn Lake on the NSW south coast. Bega Valley Shire Council

Theme 4: Protecting ecological refuge areas

Ecological refuges are places that naturally provide protection for plants and animals from threats (Selwood & Zimmer 2020). They are important to conservation because of their potential to protect species from difficult-to-manage threats such as changing climate, extreme events (such as drought and fire) and biotic threats (such as disease and invasive species). Refuges help to prevent extinction, maintain genetic diversity and the capacity of species and ecosystems to adapt to change.

Some ecological refuge areas are temporary, like the unburnt patches of vegetation that harbour the survivors of the 2019–20 bushfires. The locations of these refuges are often arbitrary, resulting from factors such as the wind conditions during the fire event. Detailed analysis and field validation is needed to identify these unburnt patches. Though temporary, these patches of unburnt and little-burnt vegetation are important sources for repopulating burnt areas. They are likely to need special protection and management so species can persist and repopulate the recovering landscape (Banks et al. 2011; Lindenmayer et al. 2009).

Other refuge areas, called refugia, provide longer-term protection, potentially over thousands of years. These persistent refugia are areas of long-term, continuous occupation by species, where multiple species survive environmental change and re-expand into newly available habitat as conditions improve (such as the unique and highly diverse rainforests of the Nightcap-Border Ranges). Persistent refugia safeguard high genetic diversity and unique evolutionary potential, and are critical to the long-term survival of multiple species. They can be identified by the genetic signatures left within these localised populations, by the presence of many endemic species, and by modelling recurrent climatic shifts.

Climate change also needs to be considered when identifying refuges and refugia. Places that provide refuge today might not support the same habitat under future climatic conditions. Areas likely to be climatically suitable can be predicted using climate change models. Such stable refugia represent priority areas for protection (if species are already present) and translocation (if species are currently absent).

Strategy 4.1 Identifying refuges

Action 4.1.1: Build comprehensive maps of potential ecological refuge areas, linked to biological data and fire science

DPIE is overlaying maps of fire extent and severity with species and ecological community maps as an initial step towards identifying potential refuge areas. This initial product was used by SoS to prioritise immediate interventions after the 2019–20 fires, and will be used in the future to identify priority areas for conservation investment.

However, the initial product does not consider all the habitat needs and vulnerabilities of individual species and ecological communities; nor does it identify places that are home to unique species or places that are suitable habitat for multiple species under climate change scenarios. This more complex analysis will be undertaken over time with input from fire ecologists to ensure the maps are linked to biological data and fire science.

Action 4.1.2: Identify habitat refuges for koalas across land tenures to optimise recovery actions and inform where to permanently protect koala habitat

Appendix A describes how refuges for koalas will be identified to support the objectives of the NSW Koala Strategy.

Strategy 4.2 Protecting refuges

Action 4.2.1: Integrate refuge maps into fire, pest and weed planning to set priorities for management actions

Note: This action responds to recommendation 36 of the NSW independent expert inquiry into the 2019–20 bushfire season.

Refuges need to be protected from extreme events, buffered from additional disturbance and complemented by good management and genetically informed restoration. This will be most effective when refuges are managed as part of a connected landscape.

The information used to identify refuge areas will be used to support strategic and operational planning decisions. For example, it may be necessary to manage pest and weed incursions into a refuge area or manage over-population of species taking refuge there. Future fire regimes need to be considered to ensure vegetation and habitat can persist within tolerable fire intervals and thresholds. Fire management should protect unburnt habitat of priority threatened species, threatened ecological communities and World Heritage Areas in the medium term, as these areas will be repopulating neighbouring burnt areas.

Action 4.2.2: Implement adaptation measures to protect critical climate change refugia, such as actions identified in the 'Gondwana Rainforest of Australia World Heritage Adaptation Plan'

Climate change adaptation in the Tweed Caldera

The parks and reserves of the Tweed Caldera in north-east New South Wales are internationally renowned for their World Heritage-listed rainforests, outstanding landscapes and recreational opportunities. They are home to the greatest diversity of marsupial, bird, snake and frog species in Australia.

The 2019–20 bushfires were an opportunity to improve our knowledge of some species' fire tolerance and recovery adaptations. For example, preliminary analysis in Nightcap National Park has shown that some rainforest species, whose fire response was previously unknown, are recovering through seeding, lignotuber shooting and epicormic reshooting. This includes *Syzygium oleosum* (blue lilly pilly) *Sarcopteryx stipata* (steelwood) and *Neolitsea dealbata* (hairy-leaved bolly gum).

More frequent fires are predicted in the future as the climate changes. Combined with other threats such as competition from feral pests, new and emergent weeds, development on reserve boundaries and changes in water use, these climate change-driven impacts will put greater pressure on habitats and the plants and animals that depend on them.

A bushfire recovery and climate change adaptation response is being developed to address the interconnected values of the Tweed Caldera and the threats facing them. The project has received funding from an Australian Heritage Grant and will aim to increase the resilience of ancient Gondwana Rainforest.

Photo: Tweed Caldera – Pinnacle Lookout across the Caldera to Wollumbin.
M Vanderveer/DPIE

The response will include protecting climate refugia and may include translocating native species to lower risk locations. For areas around climate refugia, the Macquarie University Climate-ready Revegetation guide will be applied to identify seeds and species for revegetation of buffers, which will build resilience against fires and maintain habitat structure while protecting the refugia. This will be the first on-ground application of holistic climate change adaptation measures undertaken in New South Wales, reflecting the importance the state places on these treasured World Heritage values.

Theme 5: More intensive interventions

Many species have adaptations that help them recover after bushfire. Natural mechanisms and processes provide the most effective means for biodiversity recovery. However, in the contemporary landscape these adaptations may no longer be effective, or there may not be sufficient habitat to provide the feed or shelter needed during recovery. New threats, such as invasive species, might disrupt natural patterns that once would have aided recovery.

Species unable to recover by natural processes alone, especially threatened species, may need more intensive and targeted conservation actions. These actions will be considered concurrently with in situ conservation, and could involve both landscape-scale and more intensive site-specific actions, such as:

- habitat restoration
- habitat augmentation such as creating artificial hollows
- ex situ management, genetic rescue and seed-banking to create insurance populations
- captive breeding and reintroduction, establishment of feral-free enclosures, and translocation.

Interventions will be carefully considered and implemented based on need and their likely effectiveness, how practical and feasible they are, whether they have any unintended consequences, and whether the benefits outweigh the costs. Once underway, the progress and outcomes of these intensive actions will need to be monitored and evaluated.

Strategy 5.1 Expanding conservation fencing to protect recovering ecosystems

Action 5.1.1: Expand temporary conservation fencing in fire affected areas to protect species vulnerable to predation, grazing or trampling, and recovering ecosystems

Fencing can protect recovering plants from grazing by feral herbivores and protect small native mammals from predation by feral predators. Temporary conservation fencing has been installed in a number of fire affected areas to protect vulnerable species and recovering ecosystems, and more is planned. For example, the SoS program has installed fenced enclosures to protect re-sprouting seedlings of the critically endangered Megalong Valley bottlebrush (*Callistemon megalongensis*), which are vulnerable to grazing by feral pigs and macropods.

Commonwealth funding has allowed DPIE to continue building fencing around key habitat areas for threatened plant and animal species in the Lower Hunter Spotted Gum Ironbark Forest threatened ecological community in the Sydney Basin and NSW North Coast bioregions. The fencing will help to prevent uncontrolled access into these areas, which have been heavily impacted by frequent high intensity fires, firewood collection and rubbish dumping.

Action 5.1.2: Assist fire impacted private landowners, through the Biodiversity Conservation Trust, to protect recovering vegetation from grazing, including through fencing

The NSW Government, through the Biodiversity Conservation Trust, is also assisting fire impacted private landowners with grants to protect recovering vegetation from grazing, including through fencing.

Conservation fencing for stocky galaxias in Kosciuszko National Park

Conservation fencing is helping the post-fire recovery of the stocky galaxias (*Galaxias tantangara*), a tiny native fish known from only one locality – a four kilometre stretch in the headwaters of Tantangara Creek in Kosciuszko National Park that is trout-free. The species is listed as critically endangered under the Fisheries Management Act 1994.

The stocky galaxias is at risk from the impacts of wild horses, which trample waterways, causing sedimentation, and reducing water quality. This threat is enhanced by soil erosion, runoff and sedimentation that reduces water quality after the fires.

The fence protects two vulnerable sections of the creek, totalling just under one kilometre in length. Natural barriers such as steep topography or unburnt tall and dense riparian vegetation are largely helping to keep wild horses away from the rest of the creek that the stocky galaxias call home.

To protect the population, NPWS has been supporting colleagues in Department of Primary Industries Fisheries – the lead agency for species listed under the Fisheries Management Act – by installing temporary conservation fencing to keep wild horses out of the waterway. The project includes waterway and threatened species monitoring which will help quantify the environmental benefits of the fence. The stocky galaxias will also benefit from the removal of horses from surrounding areas as part of a post-fire control program.

Strategy 5.2 Breeding, propagation and reintroduction programs

Action 5.2.1: New and expanded breeding and propagation programs for priority threatened species including the brush-tailed rock-wallaby, smoky mouse, Wollemi pine and rainforest plants (commenced as part of the Immediate Response)

As outlined in Supplements 1 and 2, DPIE implemented emergency interventions and monitoring for several plant and animal species at imminent risk of decline in the immediate aftermath of the fires, including the smoky mouse, the brush-tailed rock-wallaby, the southern corroboree frog and numerous plant species. DPIE is supporting the post-fire recovery of these and other species into the medium term by creating or maintaining insurance populations for breeding and reintroduction, building on existing work under SoS.

Commonwealth funding has supported some of these breeding and propagation programs for priority Commonwealth threatened species, including:

- expansion of captive breeding programs for the brush-tailed rock-wallaby with partners including Featherdale Wildlife Park, Taronga Conservation Society, Waterfall Springs and Currumbin Wildlife Sanctuary
- a salvage and captive breeding program for the smoky mouse, with the aim of breeding animals for release back into the wild to restock areas where they are now absent or to enhance the viability of small populations
- cultivation of Wollemi pine seedlings for re-stocking existing translocation sites affected by the fires
- propagation and re-planting of rainforest plant species, including the Nightcap oak, peach myrtle and Minyon quandong.

Action 5.2.2: Continue the NSW captive breeding programs for threatened species not covered by current Commonwealth funding including the regent honeyeater, eastern bristlebird and frog and turtle species

DPIE is also continuing captive breeding programs under the SoS program for:

- regent honeyeater
- eastern bristlebird (northern population)
- southern corroboree frog
- northern corroboree frog
- spotted tree frog
- Manning River helmeted turtle
- Bellinger River snapping turtle.

The overarching purpose of breeding and propagation programs is to establish insurance populations from which plants or animals can be reintroduced into the wild to re-establish extinct populations or supplement remaining populations. Any reintroductions of animals bred in captivity will be carefully planned and monitored to ensure the individuals are reintroduced into areas that are suitable for their needs, are disease free, and in the case of territorial animals, are not already fully occupied.

Working together to save the regent honeyeater

Once widespread across south-eastern Australia, regent honeyeater numbers are at critical levels, with only about 350 birds remaining in limited sites from north-eastern Victoria to south-eastern Queensland. The 2019–20 fires impacted the breeding, nesting and foraging habitat of the remaining populations, placing them under increased pressure.

The *Saving our Species* program is partnering with BirdLife Australia, Taronga Conservation Society, Local Land Services and the Environmental Trust to implement a conservation breeding and release project. In June 2020, 20 conservation-bred regent honeyeaters were released into the wild, the first of several planned releases. The birds were released onto private property in the Lower Hunter, where they have mixed with the wild population.

The 20 birds were raised at specialised facilities at Taronga Zoo in Sydney where they have been successfully bred for 20 years. The regent honeyeater captive breeding program has recently been expanded to include purpose-built aviaries at Taronga Western Plains Zoo.

The NSW Government, Local Land Services and BirdLife Australia are also taking action in unburnt refuge areas to increase suitable nesting sites and improve nesting success. One strategy includes controlling the abundance of noisy miners, which aggressively compete with regent honeyeaters for nectar. Fires can create habitat more favourable to noisy miners and allow them to colonise nearby unburnt areas.

Photo: Regent honeyeater after release. D Ingwersen/BirdLife Australia

Strategy 5.3 Augmenting habitats

Action 5.3.1: Continue to research the best way to replace tree hollows that are damaged or destroyed during bushfires or removed when land is cleared

As discussed in Supplement 1, the TSSC identified the loss of hollow bearing trees as a key threatening process which will impact the reoccupation of burnt forest habitat by wildlife. Scientists from DPIE are researching the best way to provide replacements for tree hollows that are damaged or destroyed during natural disasters like bushfires or removed when land is cleared for development.

While nest boxes have been used extensively for this purpose in the past, preliminary results from the Department's experiments in Warrumbungle National Park show that artificially creating tree hollows in existing trees is more effective for supporting hollow-reliant species than nest boxes. This research will inform future conservation work for hollow-dependent species.

Theme 6: Ecological monitoring, evaluation and reporting

Strategy 6.1 Deliver robust monitoring, evaluation and reporting

Monitoring and evaluation of actions is necessary to track, report on and trigger the adjustment of programs and resources where necessary to improve conservation outcomes.

Monitoring drives innovation and continual improvement in performance across conservation programs. Without robust monitoring and evaluation, there is a risk that well-intentioned action might continue despite it being ineffective or damaging, using resources that could have been directed to more effective action. A robust monitoring program that is quantitative, repeatable and meaningful can also boost public confidence and maintain ongoing support for bushfire recovery and conservation activities and investment.

Where possible, monitoring should draw on existing (pre-fire) monitoring programs to detect responses to fire. It should be integrated with broader agency and program monitoring, with data publicly shared through the SEED portal so others can use and benefit from it.

The Biodiversity Indicator Program

Action 6.1.1: Use the Biodiversity Indicator Program to measure and report on post-fire recovery of biodiversity and ecological health and the long-term impacts of fire, climate change and hydrological regimes

Note: This action responds to recommendation 36 of the NSW independent expert inquiry into the 2019–20 bushfire season

The Biodiversity Indicator Program (BIP) is the NSW Government's flagship program for monitoring and reporting the broad status and long-term trends of biodiversity and ecological health across New South Wales. The results are based on a suite of indicators that measure the status and trends of biodiversity and habitat condition over long periods of time.

Results from the first assessment released in May 2020 unveiled a hidden wealth of biodiversity against a backdrop of historical loss; although only 33% of habitat effectiveness remains in New South Wales, from 80 to 84% of original plant ecosystem diversity and 79 to 91% of within species genetic diversity persists. Threatened species continue to face extinction risk, and some bioregions are approaching thresholds of steep biodiversity loss.

The *NSW Fire and the Environment 2019–20 Summary* (DPIE 2020c) used the biodiversity indicators for habitat condition to assess the impact of the fires by measuring changes in some of the biodiversity indicators within the fire ground (see Supplement A).

Going forward, the BIP is one of the mechanisms the NSW Government will use to implement recommendation 36 of the NSW Bushfire Inquiry. Recommendation 36 requires the Government to invest in long-term ecosystem and land management monitoring, to track what is happening to ecosystems over decades under projected changes to climate, fire regimes and drought.

DPIE will use the BIP to periodically measure and report on the condition of biodiversity and ecological integrity across New South Wales, including areas impacted by the 2019–20 bushfires. Future BIP assessments will capture the progress of natural post-fire regeneration and regrowth, which will likely continue slowly for many years to come.

The models that calculate the BIP are being calibrated against on-ground evidence to ensure alignment between the BIP and other monitoring programs from across DPIE. This will support the multiple use and scalability of data across the Department.

Other monitoring, evaluation and reporting programs

Action 6.1.2: Report on specific bushfire recovery actions through current monitoring, evaluation and reporting programs

Note: This action responds to recommendation 36 of the NSW independent expert inquiry into the 2019–20 bushfire season

DPIE is carrying out several on-ground monitoring, evaluating and reporting programs to track bushfire recovery at a local scale over the short and medium term. These programs support adaptive management and informed decision-making.

Saving our Species

SoS has a program-wide framework for monitoring, evaluation and reporting on the outcomes of projects and actions. The framework incorporates governance and quality assurance of monitoring methods across the program. The monitoring, evaluation and reporting framework allows SoS to report on:

- total annual investment and the return on the investment
- threats under control or on track to be under control
- management sites and species on track to be secure in the wild in New South Wales for 100 years.

SoS will report on bushfire recovery actions taken under the program through both the species and community annual report cards and the SoS 2019–20 annual report.

Biodiversity Conservation Trust

The Biodiversity Conservation Trust commenced an ecological monitoring program in 2020 which includes monitoring state and change in biodiversity values at fire affected conservation agreement sites. Monitoring will commence in spring 2020.

WildCount

NPWS WildCount fauna monitoring uses motion-sensitive digital cameras to monitor trends in the occurrence of fauna at 204 sites in 146 national parks and reserves, and four

voluntary conservation agreement lands. Survey teams also record other information such as vegetation condition and disturbances such as fire.

The 2019–20 bushfires impacted 70 WildCount sites, with a further 22 within two kilometres of burnt areas. This presented a unique opportunity to capture post-fire recovery data and help to ground-truth fire extent and severity mapping. A total of 294,000 images were collected over 14 weeks of fieldwork. These images are being processed, but an encouraging early find includes the first ever koala record for Barool National Park in the Gibraltar Range, in a site impacted by the bushfires. Datasets from Autumn and Spring 2020 have been provided to local NPWS land managers, and records will be made available publicly on DPIE's Bionet by the end of 2020.

Monitoring feral pests on park post-fire

NPWS and the Department of Primary Industries Vertebrate Pest Research Unit are monitoring feral pests (e.g. cats, foxes, goats, deer, pigs) on NPWS reserves impacted by the 2019–20 bushfires.

The objective of monitoring is to assess the distribution, activity and abundance of feral pests in fire impacted national parks and to measure the effectiveness of post-fire management activities such as the aerial pest control program described in Supplement 1.

Monitoring is being conducted in burnt reserves as well as adjacent areas that may be of increased importance for threatened species and other wildlife impacted by fire. Monitoring includes long-term sites where available to allow comparison with pre-fire data.

NSW Forest Monitoring and Improvement Program

DPIE is participating in the design and implementation of a state-wide Forest Monitoring and Improvement Program. Led by the Natural Resources Commission, the program will deliver information and evidence to support the strategic and adaptive management of forests and forest practices on both public and private land. It will provide independent advice to forest managers in New South Wales on how policies and on-ground management can be improved, through evaluation of forest monitoring data, performance benchmarking and research.

To support the program's monitoring of post-bushfire impacts and recovery, DPIE is delivering the tools and methods to assess the effects of wildfires across tenures and identify where mitigation and recovery actions need to be implemented. This work will also help address state-wide evaluation questions on forest extent, condition and health.

Theme 7: Communication with the community

The 2019–20 fires prompted great interest and concern in the community, particularly about the impact on wildlife. There is an opportunity to build on this community interest by involving the community in wildlife recovery and conservation actions and building new community partnerships and collaborations.

People living in fire affected regions will be part of the recovery process. They will experience changes in the landscape and see on-ground management underway and may even want to participate in it themselves.

Communication will be vital to build and maintain community support for the recovery process, which will need to continue for years. That support should be based on a solid understanding of what is being done and why it is being done. Clear, accessible reporting of progress on recovery will be generated from the monitoring and reporting system and provide a degree of accountability to the community.

The results of new scientific research and the outcomes from surveys and monitoring can help to build community understanding of the ecological role of fire in the Australian

landscape. Research and monitoring results, as well as notable case studies, will be communicated in an accessible form and used to encourage community support for and participation in wildlife recovery and conservation activities.

Strategy 7.1 SEED Citizen Science Digital Hub

Action 7.1.1: Report to the community on progress of bushfire recovery and new research findings

Action 7.1.2: A new SEED Citizen Science Digital Hub is connecting community volunteers, sharing data from citizen science projects and helping people to find and sign up to conservation projects across New South Wales and learn new skills

Note: This action responds to recommendation 36 of the NSW independent expert inquiry into the 2019–20 bushfire season

Citizen science is an important way to encourage people's connection to their local environment, while generating quality data and boosting interest in local action. A key opportunity for volunteer participation in citizen science and recovery activities is the new SEED Citizen Science Digital Hub. The Hub allows community volunteers to:

- find projects across New South Wales specific to their interests, skills and availability
- connect with like-minded people to learn new skills, join projects and make direct contact with users
- sign up to projects of interest, keep track of updates, up-coming events and announcements with the Hub notification system
- see their contributions on the SEED platform and access live statistics to discover how they could be adding to environmental knowledge.

Project organisers and data users can use the Hub to:

- access a project handbook with best-practice advice on starting a project, retaining volunteers and maximising the ongoing impact of a project
- register a project and connect with volunteers suited to the project focus, requirements and location
- connect with the Hub community and make direct contact with other users to share tips, resources and find volunteers
- add data so it is widely accessible, increasing its impact on the NSW environment and showing volunteers the importance of their contributions
- access and download data, explore the dataset, and understand its validity through a transparent data quality rating.

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Appendix A – NSW Koala Strategy: Bushfire Recovery Actions

Introduction

Koalas in New South Wales, like many other species, are facing a wide range of threats, including habitat loss, disease and extreme weather events. Intense wildfire is one of these threats.

To help safeguard koalas against these threats, the NSW Government released the NSW Koala Strategy in 2018, which aims to first stabilise, then increase, koala population numbers across the state.

While fire management and the impacts of climate change are considered through actions already being taken under the NSW Koala Strategy, the scale and intensity of the unprecedented 2019–20 bushfire season and the ongoing impacts of drought require further actions to support the recovery of koala populations.

This appendix details the NSW Government's response to the impacts of the 2019–20 bushfires on koalas. The actions have been informed by a workshop led by the NSW Koala Strategy Independent Expert Panel in early February 2020. Representatives from community groups, non-government organisations, research organisations and across government participated in the workshop to identify actions to support bushfire recovery.

This appendix has three parts. Firstly, it outlines the immediate actions being implemented to support the rescue and care of koalas injured in the 2019–20 bushfires. These are followed by actions to address the short-term, and medium-term issues generated by the 2019–20 bushfires and to ensure the successful delivery of the NSW Koala Strategy in the event of future bushfires. Actions at all levels will be delivered collaboratively with DPIE's strategic partners across government and the NSW community.

What were the impacts of the 2019–20 bushfires on koalas?

As at 21 May 2020, the fire ground included over 1.9 million hectares, or 22% of the modelled high or very high suitability koala habitat in eastern New South Wales.

DPIE scientists have developed new satellite analysis techniques to rapidly assess the impact of the fires on vegetation, including identifying likely damage to the tree canopy and understorey. This analysis helps to estimate the likely impacts on koalas and identify areas of koala habitat that may act as refuges for koalas that have survived the fires. This information is also informing recovery planning.

Using satellite imagery from 28 April 2020, an initial analysis showed that the fire effect on koala habitat varied across the landscape (see Figure 3). For example, on the South Coast, over half the region's best koala habitat was affected by moderate to extreme fire severity. In the Central Coast region, less than 10% of the best koala habitat was affected by moderate to extreme fire severity.

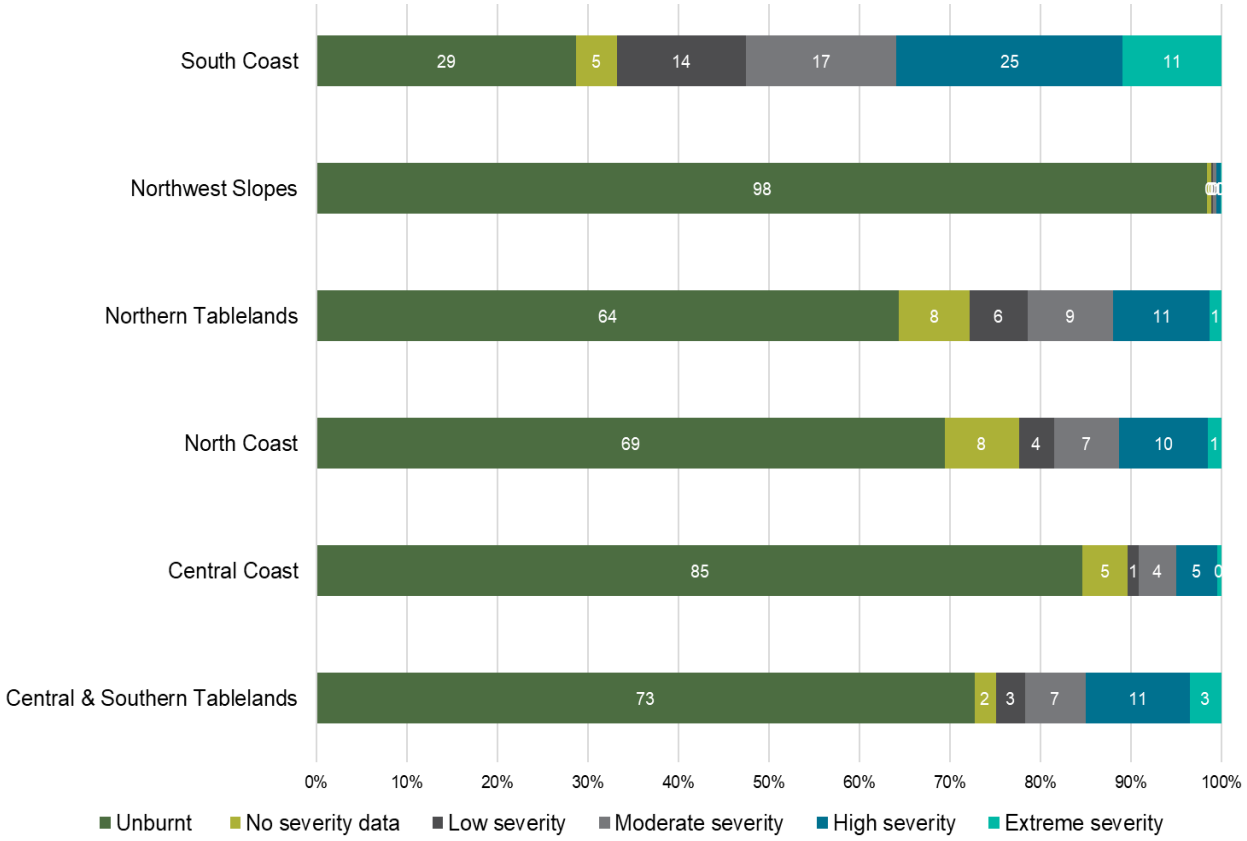

Figure 3 **Percentage of high and very high suitability koala habitat unburnt and burnt, and the relative fire severity in the burnt area**

Immediate actions: rescue and care of injured koalas

The following actions are being implemented to address the immediate needs of koalas following the 2019–20 bushfires.

Supporting wildlife rehabilitation and veterinary care

Wildlife rehabilitators, vet and vet nurses perform a critical frontline role in caring for sick, diseased and injured animals and returning them to the wild.

To assist them, the NSW Government provided $1 million in new funding to support wildlife rehabilitation and veterinary care, including $500,000 in cash grants. The first tranche of this funding was made available from 1 December 2019 for immediate needs and rescue equipment. Remaining funding is now available to fund larger assets such as trailers and diagnostic equipment.

The total funding committed by the NSW Government to support wildlife rehabilitators and provide training to vets and vet nurses in the care of native wildlife is $6.5 million.

Products to support the rehabilitation sector that have been developed by the NSW Government include:

- Koala rehabilitation training standards for the volunteer wildlife rehabilitation sector
- Guidelines for the initial treatment and care of rescued koalas
- Wildlife sector training video
- Webinar on pre-release suitability criteria for koalas
- Train-the-trainer training – online two-day course aiming to develop communication and presentation skills for wildlife rehabilitation trainers.

Coordinating the installation of drinking stations in fire affected areas

Koalas that escaped the fires were at risk of dehydration, particularly in drought affected parts of the state. To assist, DPIE partnered with the Port Macquarie Koala Hospital to install supplementary drinking stations on the North Coast and other areas of New South Wales. DPIE worked with the koala hospital to ensure the stations are located where they are most needed and are inspected and maintained regularly by local communities.

DPIE is also working with organisations and the broader community to monitor how koalas and other wildlife are using the drinking stations so that their effectiveness can be improved. Drinking stations have been installed in the North Coast, Blue Mountains, Moree, Armidale and Gunnedah.

Releasing fire severity maps to help estimate impacts on known locations of koalas

As the fires progressed through the summer, DPIE tracked their extent and severity. DPIE released fire severity maps every two weeks on the NSW Government's central resource for Sharing and Enabling Environment Data (SEED). This allowed the community to locate unburnt vegetation that could provide refuge for native fauna.

The Koala Habitat Information Base was also released in the latter part of 2019–20 through the NSW Koala Strategy. Combined with fire severity maps, the information base data layers were used to help identify the scale of the impact on known locations of koalas and will be instrumental to inform recovery efforts.

Conducting post-fire on-ground surveys

DPIE is supporting community groups and engaging contractors to undertake on-ground surveys where it is safe to enter the fire affected areas. So far, surveys have been undertaken in fire affected koala habitat in the South Coast, Southern Highlands, Mid North Coast, Far North Coast and Northern Rivers regions.

These surveys have:

- assessed the impacts of the fires on local koala populations
- identified injured koalas that need care
- assisted researchers to compare outcomes between rehabilitated and resident koalas.

DPIE has also directly undertaken a broadscale survey of fire impacts on koala populations in 24 national parks across north-east New South Wales. A total of 441 surveys were conducted across 15 study areas, using specialised koala detection dogs. Surveys were undertaken both in burnt habitat and in unburnt or mildly-burnt habitat to determine whether these areas provided refuges for koalas during the fires.

The study found that the fires had a significant impact on koalas in the national parks surveyed; however, it also showed that koalas had persisted after the fires in all study areas. Additionally, the study mapped areas of likely refugia to inform future management actions.

Understanding the impacts of fires on koala numbers and populations

Further research priorities will be identified through the next Koala Research Symposium, in early 2021. The symposium will inform any change of research priorities and the need for an updated NSW Koala Research Plan.

Providing expert wildlife care and training

Taronga Conservation Society Australia has created an e-learning module to help train vet and vet nurses to rescue, treat and rehabilitate bushfire affected wildlife, including koalas. The course includes the following content:

- how to enter a fire ground safely
- the assessment and triage of wildlife
- assessing and treating bushfire-related injuries such as burns and smoke inhalation.

Taronga's wildlife hospitals have provided treatment and care for over 100 koalas affected by drought and bushfires since October 2019.

Taronga Conservation Society has also delivered a continuing education program in wildlife treatment and care for vets, vet nurses and veterinary science students as part of the NSW Koala Strategy. The course, which has been peer-reviewed, includes a general introduction to the treatment and care of wildlife and four modules dedicated to the treatment and care of specific species, including the koala.

The online component of the course commenced on 1 June 2020. Over 100 vets, vet nurses and vet students have enrolled, with 65 full and nine partially subsidised places provided through NSW Government funding to ensure vets and vet nurses will be trained across the state. Five face-to-face workshop dates were run in October–November 2020 in Sydney and Dubbo. The course will run again in 2021.

Raising awareness about roaming domestic dog attacks

Experts agree that koalas left exposed in fire affected landscapes are particularly vulnerable to attacks by roaming domestic dogs. This risk is higher in bushland close to urban areas and can continue for many months after a fire, while the canopy and forest structure recover.

To address this risk, the NSW Government is providing funding to communities located close to fire impacted koala populations to help reduce the number of dog attacks on koalas. To date, DPIE has provided over $56,000 to Wingecarribee Shire Council, Clarence Valley Council, Campbelltown City Council and Byron Shire Council to deliver programs focused on raising awareness and changing the behaviour of dog owners. These education programs are providing signage, community engagement and targeted behavioural change programs to help reduce the number of domestic dog attacks on koalas.

Short-term actions: identifying and mitigating bushfire-induced threats

The following actions will assist the NSW Government to identify and mitigate bushfire-induced short-term threats to koalas.

Identifying habitat refuges for koalas

The widespread scale of the fires across the landscape has increased the importance of identifying and protecting areas of unburnt habitat for species that survived the initial impact of the fires. Previous studies have shown that sizeable gullies and unburnt areas within the perimeter of the fire can offer refuge for koalas. Areas of adjacent unburnt remaining habitat will also be critical to the recovery of koala populations.

Refuges and other important habitat features are being identified across land tenures using a range of techniques including:

- the Koala Habitat Information Base
- fire severity mapping
- ecological modelling of habitats and populations
- other technology such as drones and light detection and ranging (LiDAR).

This initial desktop work can form the basis for validation through on-ground assessments at a later stage, which will then inform recovery actions and prioritise permanent protection decisions.

Conservation actions across all types of land ownership and use will become increasingly important as refuge areas are identified. Prioritising conservation programs in these refuge areas is critical to prevent further loss and fragmentation of important koala habitat. It will also help to maintain connectivity across the landscape and protect koala populations and habitat into the future.

Information on long-term refuge sites will be used to identify potential locations for trial relocations. This information will also inform the release of koalas from captive breeding programs if this is identified as a long-term solution to securing koalas in the wild in New South Wales.

Establishing wildlife coordination and response teams and operating procedures

Koalas impacted by fire are often disoriented, smoke affected, hungry and dehydrated. Some may also be suffering from burns and other injuries. Following a fire, it is expected that injured and uninjured wildlife will be seen moving through and near the fire ground.

Two new wildlife coordinators have been appointed within the National Parks and Wildlife Service to incorporate wildlife rescue into operational response to emergency events and increase the volunteer wildlife rehabilitation sector's capacity to respond to emergencies (as detailed in Supplement B). In addition to supporting efforts to rescue injured wildlife in fire affected areas, the coordinators are developing training packages and new procedures with wildlife rehabilitators and fire combat agencies.

The training packages and procedures will ensure rehabilitators and firefighting personnel can access fire grounds quickly and safely to provide emergency wildlife rescue and care. They will address personal protective equipment (PPE), training and accreditation relating to operating on fire grounds, as well as the specific skill sets and equipment required to capture, handle, assess, euthanase and transport injured or orphaned wildlife.

Post-release monitoring of rehabilitated koalas

To increase the proportion of sick and injured koalas that are successfully rehabilitated to the wild and improve the suitability of release criteria, DPIE has established three post-release monitoring projects.

Two of these projects monitor the areas and tree species used by released koalas in South West Sydney and the Northern Rivers. The third project is a retrospective analysis on post-release data spanning the last 30 years. The results will give DPIE a better understanding of the response of koalas after rehabilitation and release.

Enabling Aboriginal land management

It is important to involve Aboriginal Australians in the recovery of koala populations. Aboriginal people have extensive knowledge of Country, and their cultural identity is strongly linked to Country. Koalas feature in many Aboriginal dreaming and creation stories and are a totemic species.

DPIE will partner with Indigenous Protected Areas, Joint Management Boards and Committees and Local Aboriginal Land Councils to deliver koala conservation actions. DPIE will work with Aboriginal communities to support the regeneration and protection of koala habitat through cultural land management activities, including cultural burning. DPIE will also build on actions already implemented under the NSW Koala Strategy to support Aboriginal engagement in koala habitat management.

Assessing the impacts of proposed hazard reduction burning on koala habitat and refuge sites

NPWS considers, and where necessary avoids, burning koala habitat during hazard reduction operations. Koalas and other threatened species are considered through the environmental assessment processes for hazard reduction burning including the Bush Fire Environmental Assessment Code, Bush Fire Hazard Reduction Certificate and Review of Environmental Factors processes. In some cases, NPWS actively protects koala habitat through hazard reduction programs.

NPWS is also undertaking a strategic environmental impact assessment process in response to the impacts of the 2019–20 bushfires. This process aims to identify the impacts of proposed hazard reduction burns on high quality koala habitat and unburnt refuge areas to reduce the impacts of hazard reduction operations on these important environmental features.

Conservation of koala habitat on private land

Following the 2019–20 bushfire season, the Biodiversity Conservation Trust (BCT) will continue to prioritise and invest in the protection of koala habitat via private land conservation agreements. The BCT recently closed a koala-focused conservation tender in the Southern Highlands. It is expected to announce a suite of new in-perpetuity agreements on koala habitat in this area soon.

None of the properties that entered into a private land conservation agreement to protect koala habitat on the North Coast has been affected by the bushfires; however, the bushfires have impacted more than 50,000 hectares across 250 properties covered by private land conservation agreements across the state. The BCT will support impacted landholders with technical advice or financial assistance. More information is available on the Biodiversity Conservation Trust website.

Medium-term actions: improving our response to natural disasters

Measuring long-term trends in koala populations

DPIE has developed a cross-tenure Koala Monitoring Framework as part of the NSW Koala Strategy. This provides a structure for long-term koala monitoring across multiple public and private land uses, organisations and institutions. Implementation of the framework will lead to robust data on the status of koala populations across the state over a time period sufficient to detect trends. This will provide a better understanding of the recovery of koala populations impacted by the fires and drought.

Translocating koalas to support population recovery

The NSW Koala Strategy commits to trialling the relocation of koalas to unoccupied koala habitat if it is determined to be the best way to keep them safe from human activity. DPIE is partnering with researchers to investigate the effectiveness and challenges of relocating koalas within New South Wales, and the results will be used to inform any subsequent relocation trials. The NSW Koala Strategy also includes a commitment to establish the Australian Museum as the biobank for koala genetic information, which can also be used to inform translocation trials.

In response to the bushfires, captive breeding of koalas for wild release is being considered by wildlife rehabilitation groups for the recovery of some local populations. Translocation and relocation programs may also be considered to support recovery.

It is important that any captive breeding or relocation programs are informed by a range of factors including detailed genetic information about the source and recipient koala populations. It is also important that these programs are guided by an agreed framework to ensure a coordinated approach and to safeguard the genetic diversity of koala populations. DPIE will work with wildlife rehabilitation groups to help develop an informed and coordinated approach to this work as it progresses.

Appendix B – NSW Bushfire Inquiry recommendations addressed as part of the medium-term response plan

The following recommendations, made by the NSW Bushfire Inquiry in its final report, have been either fully or partially addressed as part of the *NSW Wildlife and Conservation Bushfire Recovery: Medium-term response plan*.

Recommendation 19

That Government re-commit to the current, regionally based approach to planning and coordinating hazard reduction activities across all tenures through Bush Fire Management Committees but ensure that it is actually being implemented at a high-level of quality across NSW. Getting it to a high-level of quality requires:

a. implementing the Inquiry's recommendation about performance auditing of Bush Fire Risk Management Plans
b. prioritising implementation of revised processes for bush fire risk management planning that incorporate new modelling and methods for quantifying risk and the residual risk profile as a result of proposed hazard reduction works
c. ensuring regional priorities for hazard reduction, and how they are determined, are communicated clearly to the community, and their implementation is reported on transparently. This will include being very clear about the objectives of hazard reduction activities and communicating that hazard reduction does not eliminate the risk of fire affecting properties
d. the methodology for assessing and planning for risk reduction becomes an ongoing area of research and the frameworks are formally reviewed every three years.

Recommendation 20

That Government, noting that hazard reduction targeted in proximity to assets is on balance more likely to provide help than hinder, should:

a. support local councils and partner agencies to implement more comprehensive hazard reduction at a local level around towns/cities, communities and local infrastructure assets, and provide incentives for communities to organise themselves to prioritise and implement local hazard reduction initiatives. This will involve a suite of hazard reduction techniques depending on the landscape including prescribed burning, clearing, mowing, and mechanical treatments, and easy disposal of green waste into processors turning it into bioenergy or biofuels
b. beyond the local level priorities for hazard reduction, prioritise prescribed burning in parts of the landscape where fuel treatment may help reduce probability of fires escalating quickly and where terrain and potential atmospheric interactions are likely to escalate fires into fire-generated thunderstorms. This will likely involve a proactive program of treating ridge tops that are prone to dry lightning where reduced fuels may help reduce speed of spread when the fire first starts, or particular windward or lee-slopes that are susceptible to generating extreme fire behaviour and drive fire towards towns.

Recommendation 21

That, in order to improve understanding of optimal hazard reduction techniques and their application in the landscape:

a. Government extend the recently introduced program of mitigation crews so that hazard reduction activities can be undertaken when conditions are optimal (throughout the week and potentially at night)
b. all fire authorities review prescribed burning techniques and their implementation, and commission further research into optimal prescribed burning regimes and techniques. This should include research to understand critical thresholds that, when breached, may render fuel treatment ineffective (i.e. fuel moisture thresholds), and the short, medium and long-term outcomes of hazard reduction burning regimes
c. Government commission research into a range of other hazard reduction techniques to understand better the cost versus benefit and effectiveness of different practices in various circumstances, including grazing.

Recommendation 25

That Government adopt the principle that cultural burning is one component of a broader practice of traditional Aboriginal land management and is an important cultural practice, not simply another technique of hazard reduction burning.

Recommendation 26

That, in order to increase the respectful, collaborative and effective use of Aboriginal land management practices in planning and preparing for bush fire, Government commit to pursuing greater application of Aboriginal land management, including cultural burning, through a program to be coordinated by Aboriginal Affairs and Department of Planning, Industry and Environment working in partnership with Aboriginal communities. This should be accompanied by a program of evaluation alongside the scaled-up application of these techniques.

Recommendation 36

That Government invest in long-term ecosystem and land management monitoring, modelling, forecasting, research and evaluation, and harness citizen science in this effort. This will include, among other things:

- tracking and trying to forecast what is happening to ecosystems over decades under projected changes to climate extremes, including fire regime change
- better understanding interaction of fire with other disturbances, e.g. drought, hydrological changes in the landscape
- commissioning experiments and feasibility studies for ecosystem adaptation experiments – for example, facilitating shift of high conservation-value rainforest vegetation communities further south as climatic conditions change
- better understanding the influence of different land management practices on landscape flammability (in different landscapes) over the short, medium and long-term, and enabling an adaptive management approach.

Recommendation 45

That, in order to prioritise early suppression and keep fires small:

a. Government set a KPI for NPWS regarding the percentage of fires that start on-park and are contained within 10 hectares, and consider whether 70% is an appropriate KPI for the NSW RFS and NPWS
b. NSW fire authorities deploy remote area fire fighting resources based on enhanced research and predictive modelling. In some circumstances, this may require prioritising the deployment of RART to enable rapid initial attack of new remote area ignitions over ongoing suppression operations, where supported by a relative risk assessment.

Recommendation 53

That Government develop and implement a policy on injured wildlife response, rescue and rehabilitation including:

a. a framework for the co-ordination and interaction with emergency management structures
b. guidelines for Incident Management Plans to include wildlife rescue and rehabilitation as a consideration
c. a requirement for all vets and wildlife rescue volunteers to obtain the Bush Fire Awareness accreditation
d. guidance for firefighters on handling injured wildlife.