Fire extent and severity mapping: report for the 2023–24 fire year

Department of Climate Change,
Energy, the Environment and Water

NSW GOVERNMENT

Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live.

We pay our respects to Elders past, present and emerging.

This resource may contain images or names of deceased persons in photographs or historical content.

Artist and designer Nikita Ridgeway from Aboriginal design agency Boss Lady Creative Designs created the People and Community symbol.

Cover photo: An aerial view of smoke and flames from the Murrumbucca fire north of Cooma. Sue Brookhouse/DCCEEW

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Introduction

We use information about the severity of fire in the landscape to understand the relationship between fuels and fire behaviour, and species, ecosystems and landscape ecology.

Scientists from the Department of Climate Change, Energy, the Environment and Water's Science and Insights Division, in collaboration with the NSW Rural Fire Service (RFS), use a semi-automated remote sensing system to map fire extent and severity in New South Wales.

Bushfires are part of a natural cycle in our environment. However, they are increasing in frequency, severity and extent. They also continue to encroach on urban areas. This makes fire an increasing threat for environmental management in New South Wales.

We produce maps of individual fires in near real-time via the fire extent and severity mapping (FESM) system.

Each year, we combine these maps into a mosaic. These maps tell us about changes in vegetation due to fire. This enables us to better understand how future fire events may unfold. It also tells us about how these events affect the environment. We use this information in our fire response and recovery efforts.

This report summarises the FESM analysis for the 2023–24 fire year. This year marked 4 years since the black summer of 2019–20. In 2023–24, a total of 82,425 hectares of wildfire burnt within the 2019–20 fire ground. This includes 20,683 hectares that was burnt at high or extreme severity in both 2019–20 and 2023–24 fires.

High frequency fire and short fire intervals can disrupt lifecycle processes in flora and fauna. This can cause the loss of vegetation structure and composition. This is a key threatening process under the Biodiversity Conservation Act.

Our webpage *Recovering from the 2019–20 fires* (link in 'More information') includes:

- the effects of the extreme 2019–20 season of mega-fires
- the things that influence fire regimes and climate change
- links to our progress in implementing the recommendations of the NSW Bushfire Inquiry 2020.

This is the fifth report in the series. It is accompanied by a data spreadsheet for the 2023–24 fire year. Previous reports have covered the fire years 2016–17 to 2022–23. The FESM annual report for 2024–25 will be released once data processing is completed after June 2025.

You can access the FESM spatial data on the Sharing and Enabling Environmental Data (SEED) portal (see 'More information').

You can find out more about the FESM system on the *Fire extent and severity maps* webpage (link in 'More information').

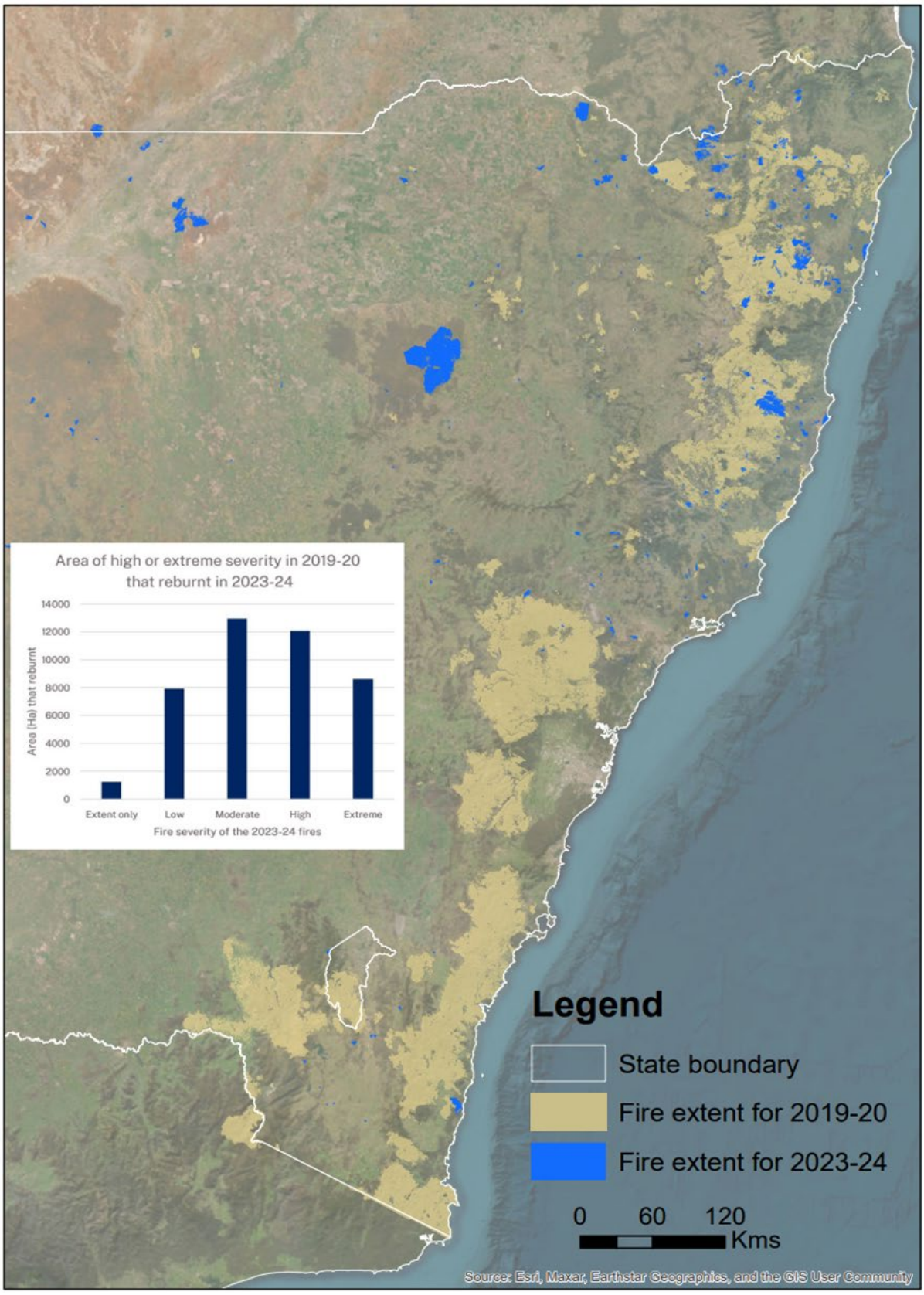

Figure 1 **Map of the eastern part of New South Wales showing the fire extent of the 2019–20 fire year overlaid with the fire extent of the 2023–24 fire year. The inset bar graph shows the area that was burnt at high or extreme severity in 2019–20, and which was reburnt in 2023–24 across all severity classes**

How the FESM system works

FESM is a remote sensing assessment of fire extent and severity. It measures the loss or change in vegetation caused by fire.

FESM uses machine learning trained on fire severity class samples from approximately half a million points of training data. This data is interpreted from high-resolution post-fire aerial photography.

Table 1 describes FESM fire severity classes.

Table 1 FESM fire severity classification

Severity class	Description	Percentage foliage fire-affected
Unburnt	Unburnt surface with green canopy	0% canopy and understory burnt
Extent only	Burnt surface (grass fires)	100% burnt area
Low	Burnt understory with unburnt canopy	> 10% burnt understory > 90% green canopy
Moderate	Partial canopy scorch	20–90% canopy scorched
High	Full canopy scorch (+/– partial canopy consumption)	> 90% canopy scorched < 50% canopy biomass consumed
Extreme	Full canopy consumption	> 50% canopy biomass consumed

In July 2020, we launched the operational automated system developed in collaboration with the NSW RFS. This delivers fire extent and severity maps in near real-time.

You can find out more about the FESM method on the *Fire extent and severity maps* webpage (see 'More information').

Accuracy and future improvements

FESM is peer reviewed and rigorously validated. It continues to be updated and refined.

The accuracy statistics for FESM have been independently assessed using high-resolution post-fire aerial photography as well as post-fire field surveys.

Independent aerial photo and field validation data used to assess the accuracy of the latest FESM version 3 (FESMv3) algorithm shows that accuracy is:

- between 85% and 95% for unburnt and extreme severity classes
- between 75% and 85% for low, moderate and high severity classes.

We know that FESM is less accurate where there is topographic roughness, high canopy density and in wetter areas (Gibson et al. 2020).

While FESM is based on the best available information, future versions of the algorithm will incorporate refined methods and better training data for more accurate results.

Comparison between satellites

Fires mapped from the 2017–18 fire year and later, including those in this report, use Sentinel 2 satellite imagery, while fires mapped in the 2016–17 fire year or earlier use imagery from the Landsat platform.

White and Gibson (2022) have evaluated inherent sensor differences between Sentinel 2 and Landsat. Independent accuracy assessment demonstrated very similar levels of accuracy for both sensor algorithms.

Overall, there is strong support for the combined use of both sensors in remote sensing applications for FESM (White and Gibson 2022).

Extent only update

From 2022–23, a refinement to the processing method was adopted to include an additional FESM class representing fire extent only in open grassy areas (see Table 1).

This avoids over-representation of high and extreme severity mapping in grassy areas.

The update allows the FESM processing system to retain severity mapping within sections of wooded areas, delineated by visual interpretation of imagery by a remote sensing expert analyst.

From 2022–23 onwards, the reported figures for fire extent may differ from the sum of the severity classes, due to this additional extent-only class in open grassy areas.

NSW statewide assessment of fire extent and severity for the 2023–24 fire year

The fire season of 2023–24 had the most fire activity since the 2019–20 bushfire crisis.

Wildfires were concentrated in the north-east and scattered across much of the central and west (Figure 1 and Figure 2).

Australia had its driest 3 months on record from August to October 2023. This was followed by above average summer rainfall (AFAC 2024).

Several large fires with erratic behaviour burnt from July to October 2023, including the Willi Willi Road and Coolagolite fires (Figure 3).

The Duck Creek Pilliga fire started on 8 December 2023 (Figure 4). This was the largest fire event of the year. There were 2 fire thunderstorm events associated with this fire recorded on 9 December and 18 December (McRae 2024).

The 2023–24 fire year had a large proportion of fires in central and western NSW, with large areas of grass fires. Grassy fuel biomass has increased following several years of above-average rainfall. This may generate an increased risk of wildfires in the coming years (AFAC 2024).

A total of 82,425 hectares of wildfire burnt within the 2019–20 fire ground (Table 2). This included 20,683 hectares that was burnt at high or extreme severity in both 2019–20 and 2023–24 fires.

Given the vast extent of the 2019–20 fireground, there is heightened risk of consequences to flora and fauna. We also expect there will be changes to vegetation structure, composition and function due to high frequency, short interval fires.

This highlights an urgent need to reduce fire recurrence in areas recently or frequently burnt.

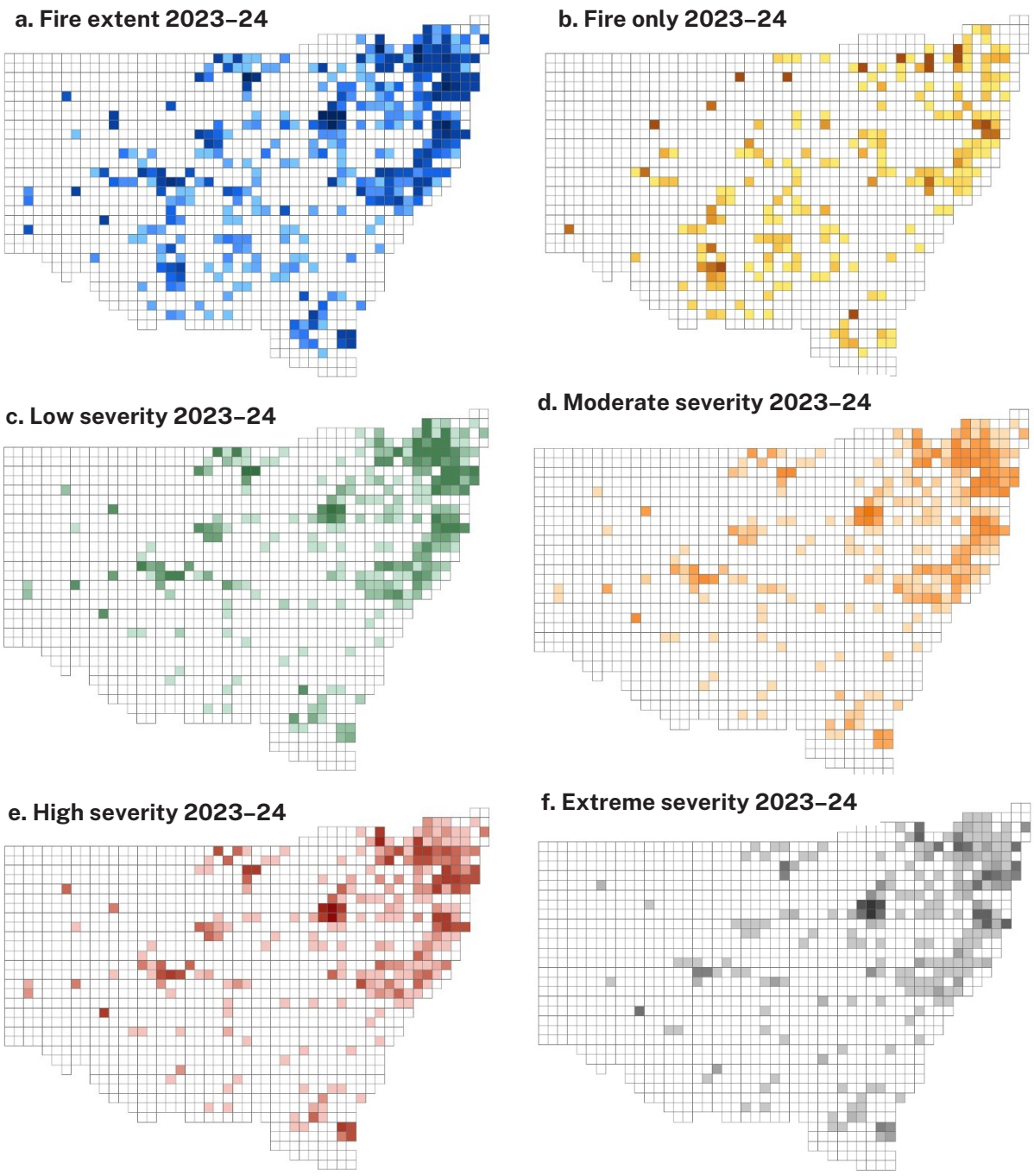

Figure 2 **Geographic distribution of fire extent and fire severity across New South Wales for the 2023–24 fire year: (a) fire extent, (b) extent only (grass fires), (c) low severity, (d) moderate severity, (e) high severity and (f) extreme severity**

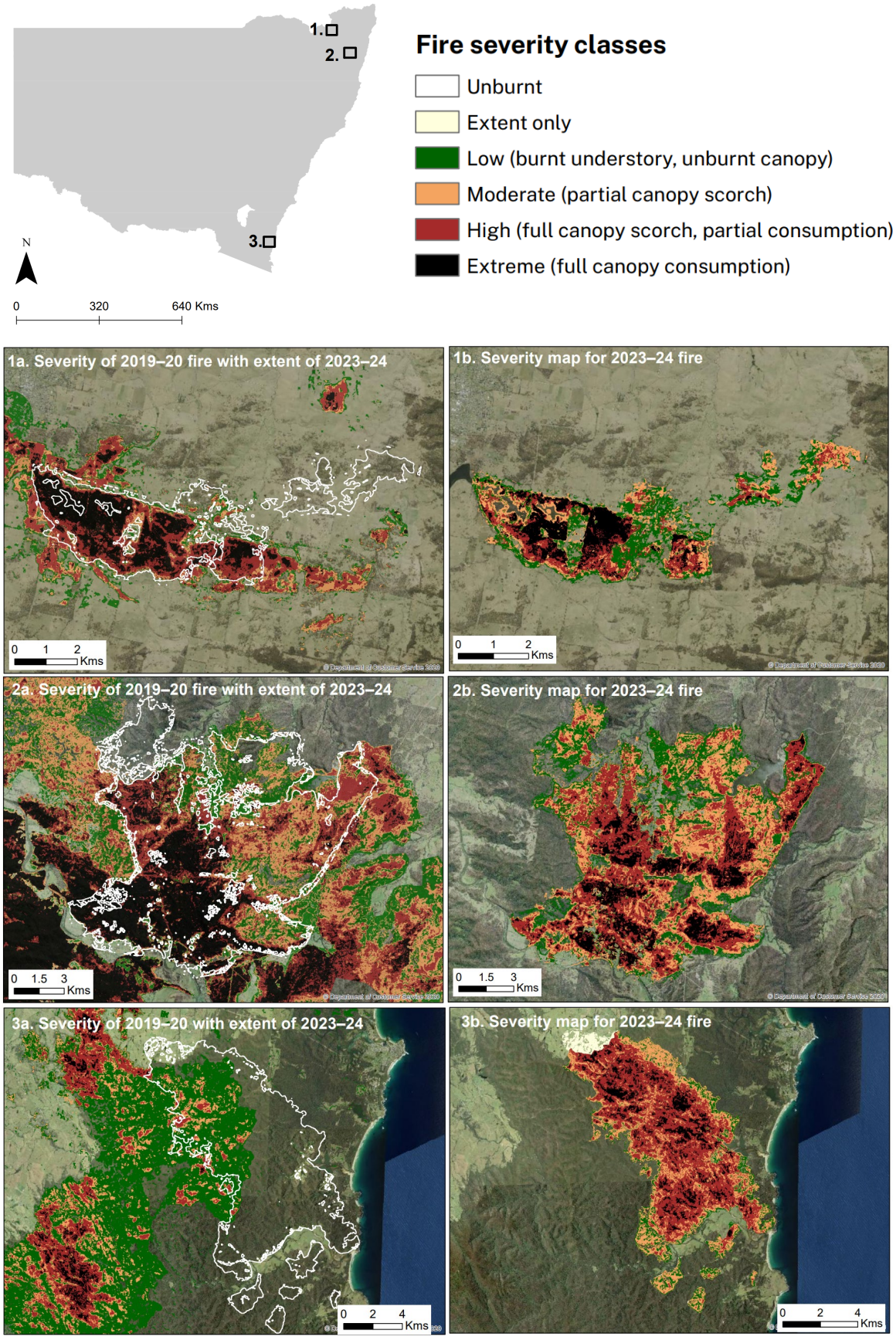

Figure 3 **FESM mapping for 2023–24 for 3 notable fires that burnt over the 2019–20 fireground: 1. Scrub Road, Tenterfield; 2. Glens Creek Road, Nymboida; 3. Coolagolite Road, Coolagolite**

Table 2 **Area in hectares of the 2019–20 fire ground that reburnt in 2023–24 across New South Wales**

2019–20 FESM	Extent only	Low	Moderate	High	Extreme	Total reburnt
Low	2,088	4,935	5,187	3,555	1,116	16,882
Moderate	954	7,197	8,607	4,770	1,233	22,760
High	574	5,064	7,356	5,769	2,181	20,944
Extreme	665	2,868	5,574	6,292	6,441	21,840
Total reburnt	4,281	20,064	26,724	20,386	10,971	82,425

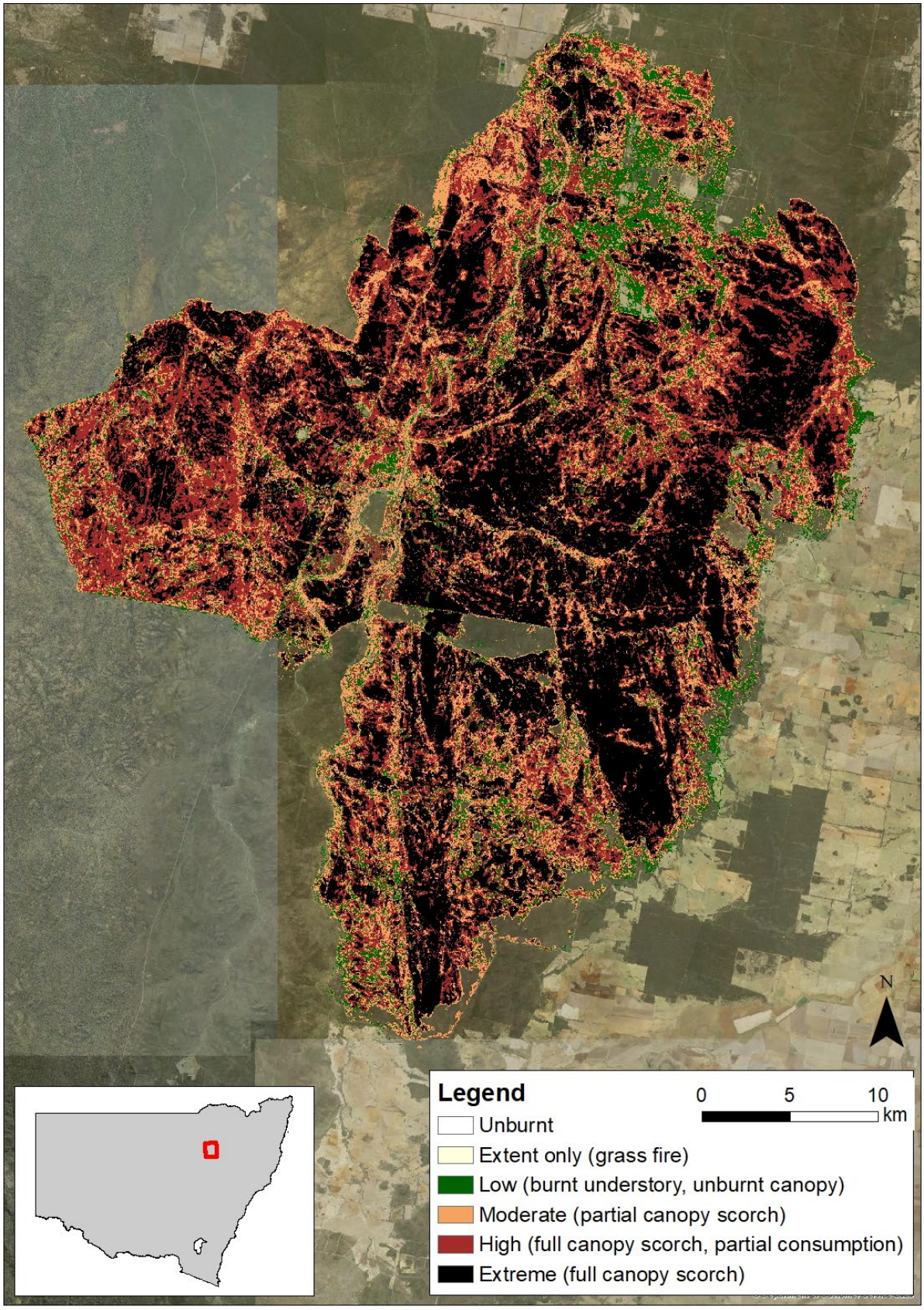

Figure 4 **Fire extent and severity map of the Duck Creek, Pilliga fire, which burnt from 8 December 2023 to 8 January 2024**

Reporting breakdowns for the 2023–24 fire year

To help decision-makers and conservation efforts, NSW reports on fire extent and severity in different ways depending on land management and ecological units. You can download the complete datasets from the SEED portal (see 'More information').

This section summarises NSW fire extent for 2023–24 across:

- Interim Biogeographic Regionalisation for Australia (IBRA) bioregions
- lands managed by the NSW National Parks and Wildlife Service (NPWS)
- vegetation formations (Keith 2004).

Fire extent across Interim Biogeographic Regionalisation for Australia bioregions

The Brigalow Belt South and NSW North Coast had approximately quadruple and double the area burnt, respectively, compared with the rest of the IBRA regions (Figure 5).

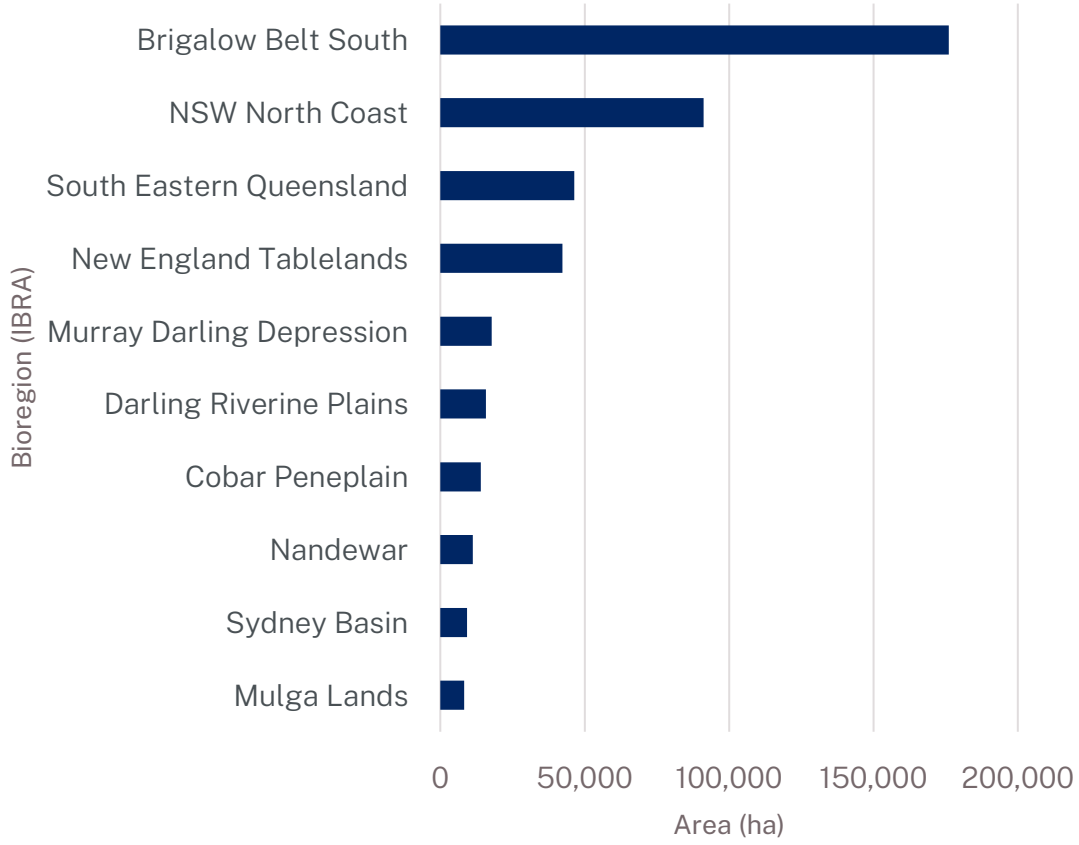

Figure 5 **Area burnt in each IBRA bioregion in the 2023–24 fire year. The top 10 bioregions with highest burnt area have been included here**

Fire extent across NPWS-managed lands

Pilliga Nature Reserve (NR) and Pilliga East CCAZ3 State Conservation Area had the largest burnt area across NPWS-managed lands in the 2023–24 fire year (Figure 6). Fires burnt 27,661 ha and 17,921 ha (33% and 73%) of the parks, respectively.

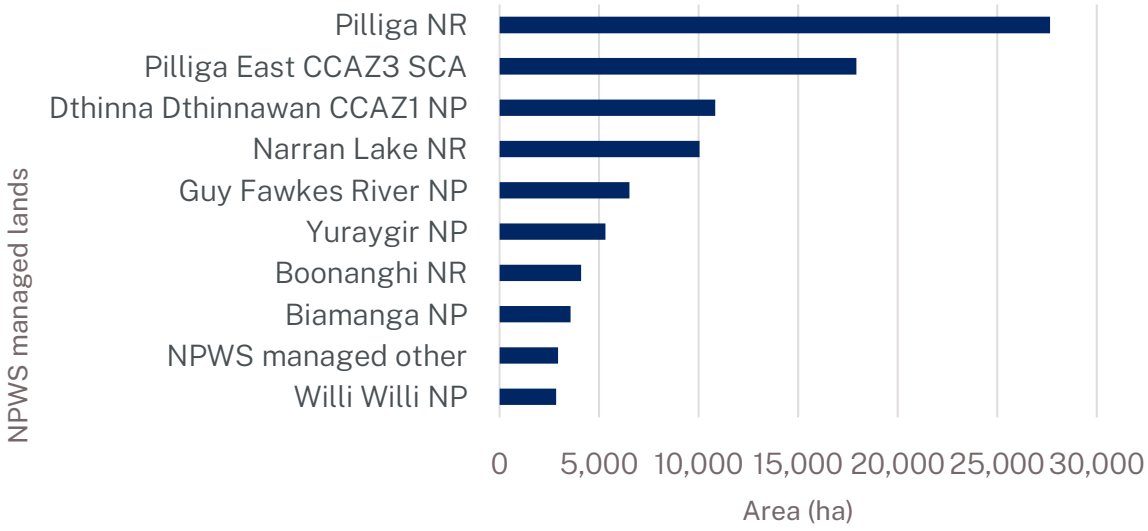

Figure 6 **Area burnt in NPWS-managed lands in the 2023–24 fire year. The top 10 NPWS-managed lands with the highest burnt area have been included here**

Fire extent across NSW Keith vegetation formations

The vast majority of the area burnt in 2023–24 ocurred within dry sclerophyll forests shrub (Figure 7). This was more than double the area burnt in any other formation in 2023–24.

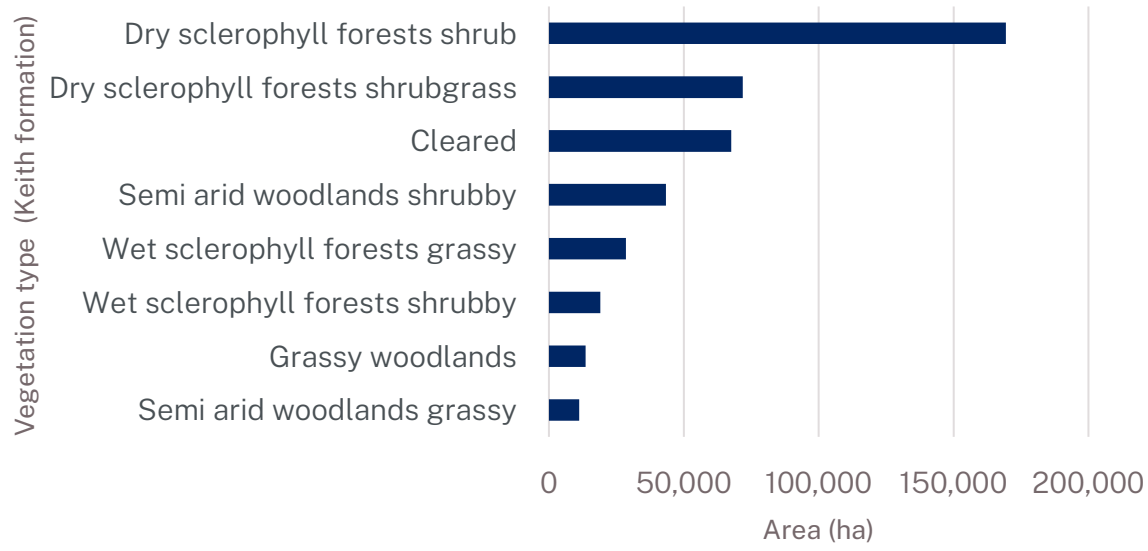

Figure 7 **Area of Keith vegetation formations burnt in the 2023–24 fire year. Vegetation formations with more than 10,000 hectares burnt have been included here**

Comparison with previous years

This section provides a comparative assessment of the 2023–24 fire year with previous consecutive 5 fire years of statewide severity mapping: 2022–23, 2021–22, 2020–21, 2019–20 and 2018–19.

Future reports will compare a rolling window of the study year with the previous 5 years.

The 2023–24 fire year had much higher fire activity overall, compared with the years since the extreme 2019–20 fire year (Figure 8a, and Figure 9).

Fire extent has increase by threefold each year since 2019–20.

A large proportion of the area burnt in 2023–24 occurred in the north and north-eastern parts of the state.

Fire activity in the south-east coast and Alpine region of the state remained low in 2023–24 compared with the fire years from 2017–18 to 2019–20 (Figure 9d–f).

The large Coolagolite Road fire in the Bega Valley was an exception. It reburnt 2,223 hectares of 2019–20 fire ground.

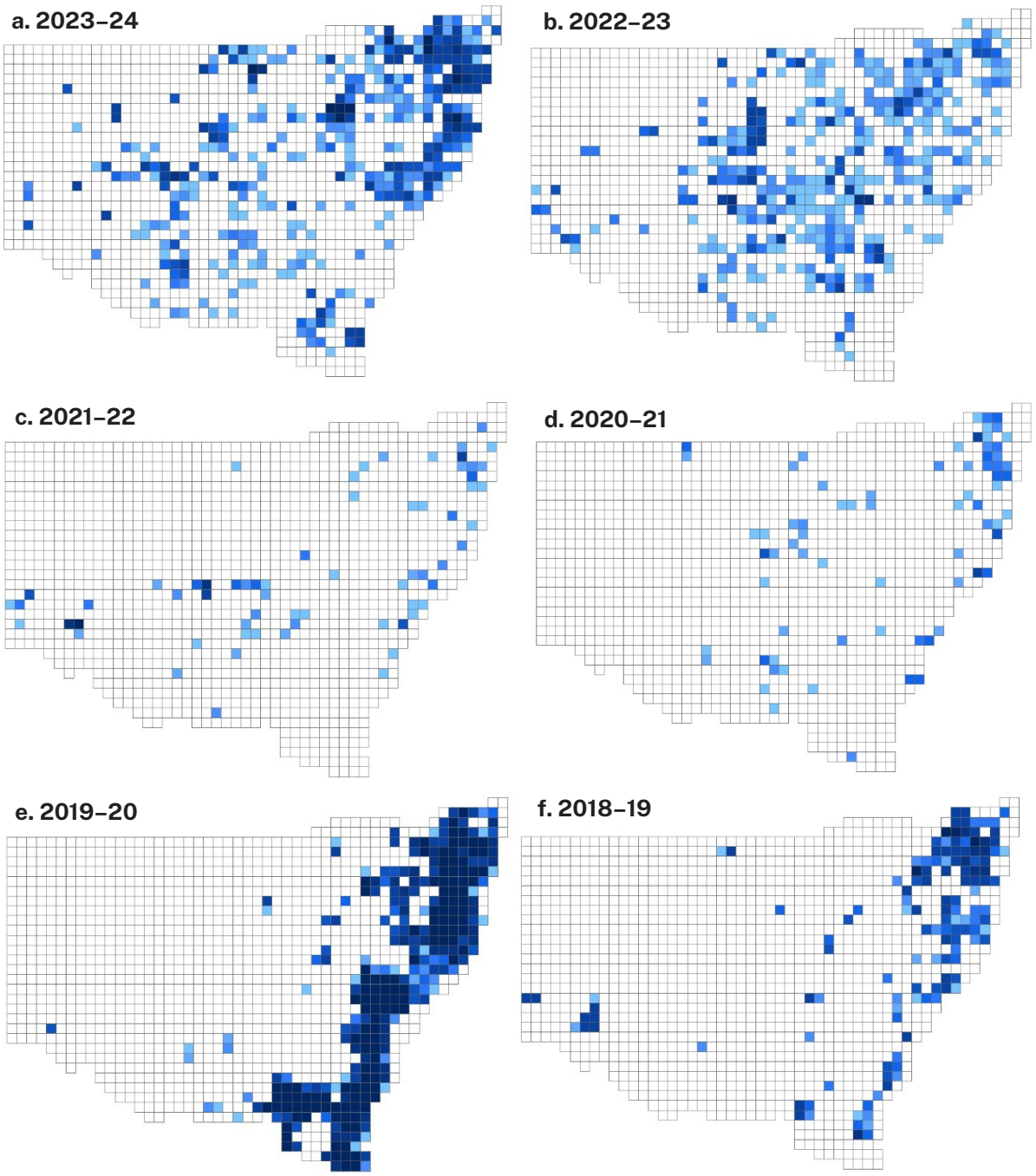

Figure 8 **Geographic distribution of fire extent (area burnt) across New South Wales for the 2023–24 fire year (a), and previous fire years: (b) 2022–23; (c) 2021–22; (d) 2020–21; (e) 2019–20 and (f) 2018–19**

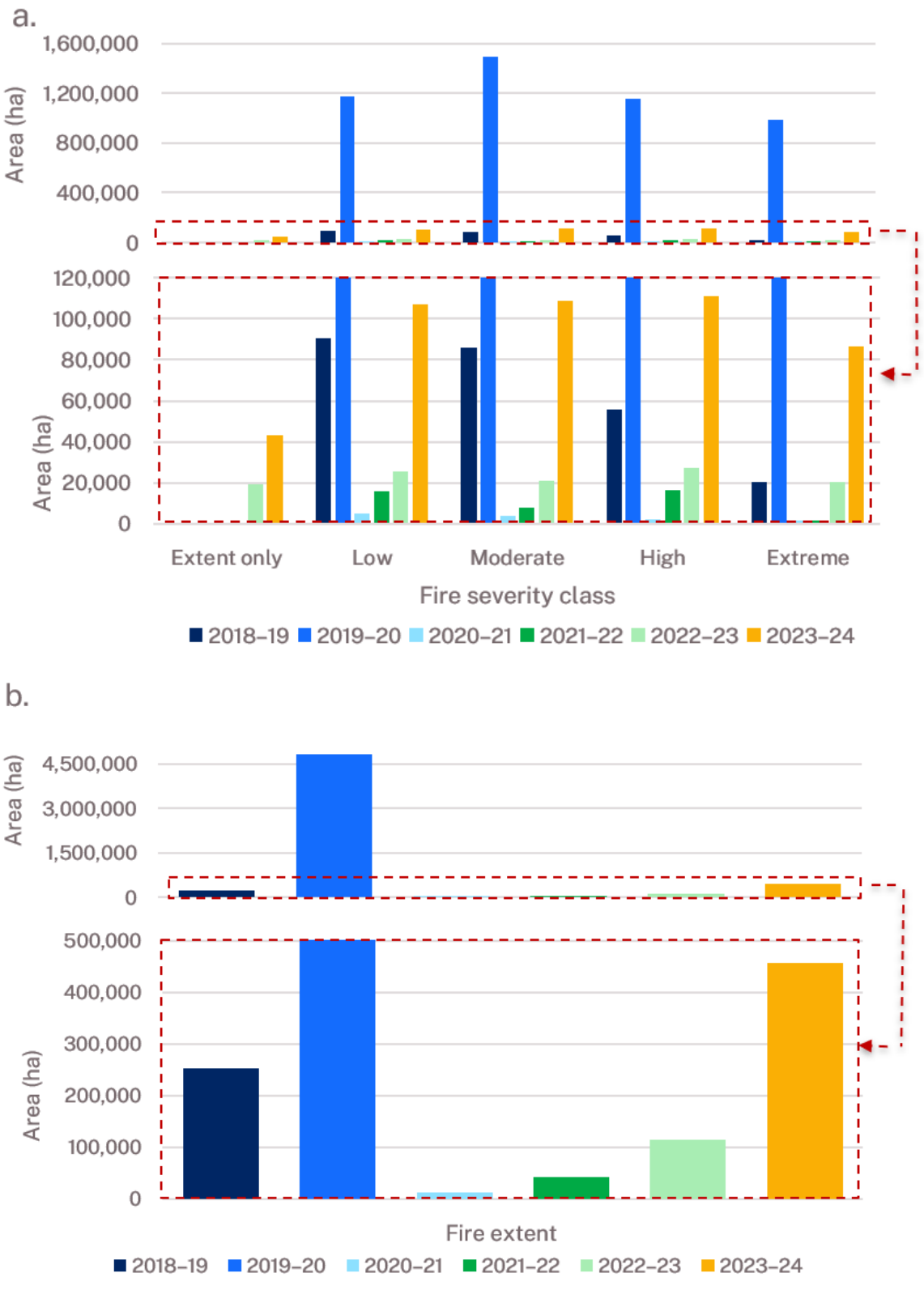

Figure 9 **Comparison of a. fire severity and b. fire extent between 2023–24 and the previous 5 fire years**

Note: the 2 panels of each figure are on different scales, with the lower panel excluding 2019–20 data above 120,000 and 500,000 hectares for a. and b. respectively. Extent only (that is grass fires) is only available from 2022–23 onwards.

More information

Webpages and fact sheets

- Landcover monitoring and reporting, NSW Department of Climate Change, Energy, the Environment and Water
- Fire extent and severity maps, NSW Department of Climate Change, Energy, the Environment and Water
- Recovering from the 2019–20 fires, NSW Department of Climate Change, Energy, the Environment and Water
- Supporting fire management with the fire extent and severity maps: Fire mapping by machine learning fact sheet, NSW Department of Climate Change, Energy, the Environment and Water

Data availability

- Fire extent and severity mapping datasets for all fire years are available on the SEED portal
- Fire extent and severity mapping results for the 2023–24 fire year, along with results from previous years, are available on the Fire extent and severity maps webpage.

References

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McRae R (2024) Australian PyroCb Register, May 2024. https://www.highfirerisk.com.au/pyrocb/register.htm

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