Fire extent and severity mapping

Report for the 2022–23 fire year

Department of Planning and Environment

Acknowledgement of Country

The Department of Planning and Environment 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This resource may contain images or names of deceased persons in photographs or historical content.

Cover photo: Ledknapper hazard reduction burn. Melissa Hams/DPE

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Introduction

Information about the severity of fire in the landscape is critical for understanding the relationship between fuels, fire behaviour and species, ecosystems and landscape ecology. Remote sensing scientists from the Department of Planning and Environment's (the department's) Science, Economics and Insights Division, in collaboration with the NSW Rural Fire Service (RFS), have developed a remote sensing–based, semi-automated approach to fire extent and severity mapping (FESM) in New South Wales.

Although bushfires are part of a natural cycle in our environment, they are increasing in frequency, severity and extent and continue to encroach on the wildland–urban interface. This makes fire an increasing threat for environmental management in New South Wales. We produce maps of individual fires in near real-time throughout each fire season via the FESM system. These maps are combined into an annual mosaic at the end of each season. Analyses of these maps provides information on vegetation changes due to fire. This enables our scientists to better understand how future fire events may unfold and the potential impacts of these events on the environment. The analyses and data can assist governments, fire managers, and conservation and landscape ecology researchers to understand and respond to the environmental effects of fire for ongoing fire research and post-fire recovery efforts.

This report summarises the FESM analysis for the 2022–23 fire year; 3 years after the black summer of 2019–20. This is the fourth report in the series. Previous reports have covered the fire years 2016–17 to 2021–22. Future annual reports will be routinely issued in August each year, and will cover the most recent fire year (i.e. the FESM annual report for 2023–24 will be released in August 2024).

This summary report is accompanied by a data spreadsheet for the 2022–23 fire year. The FESM spatial data are made available on the Sharing and Enabling Environmental Data (SEED) portal at the end of each fire year. More information about the FESM system can be found on our *Fire extent and severity maps webpage* (see 'More information' below).

Our webpage entitled *Recovering from the 2019–20 fires* also includes information on understanding the effects of the extreme 2019–20 season of mega-fires, what influences fire regimes and climate change and provides links to progress being made in implementing the accepted recommendations of the NSW Bushfire Inquiry 2020.

How the fire extent and severity mapping system works

FESM is a remote sensing assessment of fire extent and severity that 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 training data points, interpreted from high-resolution post-fire aerial photography. The FESM fire severity classes are described in Table 1.

Table 1 Fire extent and severity mapping 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, the operational automated system developed by the department in collaboration with the NSW RFS was launched, delivering fire extent and severity maps in near real-time. While FESM is based on the best available information, it is anticipated that future versions of the algorithm will incorporate refined methods and enhanced training data for improvements in accuracy.

Further information on the FESM method is available on our *Fire extent and severity maps* webpage.

Accuracy and future improvements

The FESM approach has been peer reviewed and rigorously validated and 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.

FESM is known to have reduced accuracy with topographic roughness, high canopy density and in wetter areas that change significantly in optical reflectance signals over short time periods, especially through summer (Gibson et al. 2020). To help inform the improvement of future FESM models, detailed assessments of the performance of the modelling across vegetation type, terrain and climatic regions using high-resolution aerial photography interpretation and post-fire field assessments are ongoing.

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. Inherent sensor differences between Sentinel 2 and Landsat have been evaluated by White and Gibson (2022).

Independent accuracy assessment demonstrated very similar levels of accuracy for both sensor algorithms. There was substantial agreement between the outputs from the 2 sensors. Differences between outputs are likely partly due to differences in sensor resolution (10 m and 30 m pixel sizes for Sentinel 2 and Landsat 8, respectively) and may be influenced by landscape complexity, such as terrain roughness and foliage cover. 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

In previous fire years, fire extent has been represented simply by the sum of the severity classes. However, in 2022–23, a large proportion of burnt area in New South Wales occurred in open grassy ecosystems across the central and western parts of the state. This instigated a refinement to the processing method to include an additional FESM class representing fire extent only in open grassy areas (see Table 1). 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 2022–23 fire year

The fire season of 2022–23 had much higher fire activity than the previous 2 years. The high rainfall and relatively mild temperatures associated with La Niña conditions from 2020 to 2022 has promoted biomass growth, which may now be drying out and increasing in flammability (Shikwambana et al. 2022). A high proportion of total fire occurred inland in the centre and west of the state (Figure 1). The very high rainfall and flooding across coastal parts of New South Wales during the 2021–22 fire season, combined with the extensive burnt area from 2019–20, is likely to have suppressed fire activity in coastal areas.

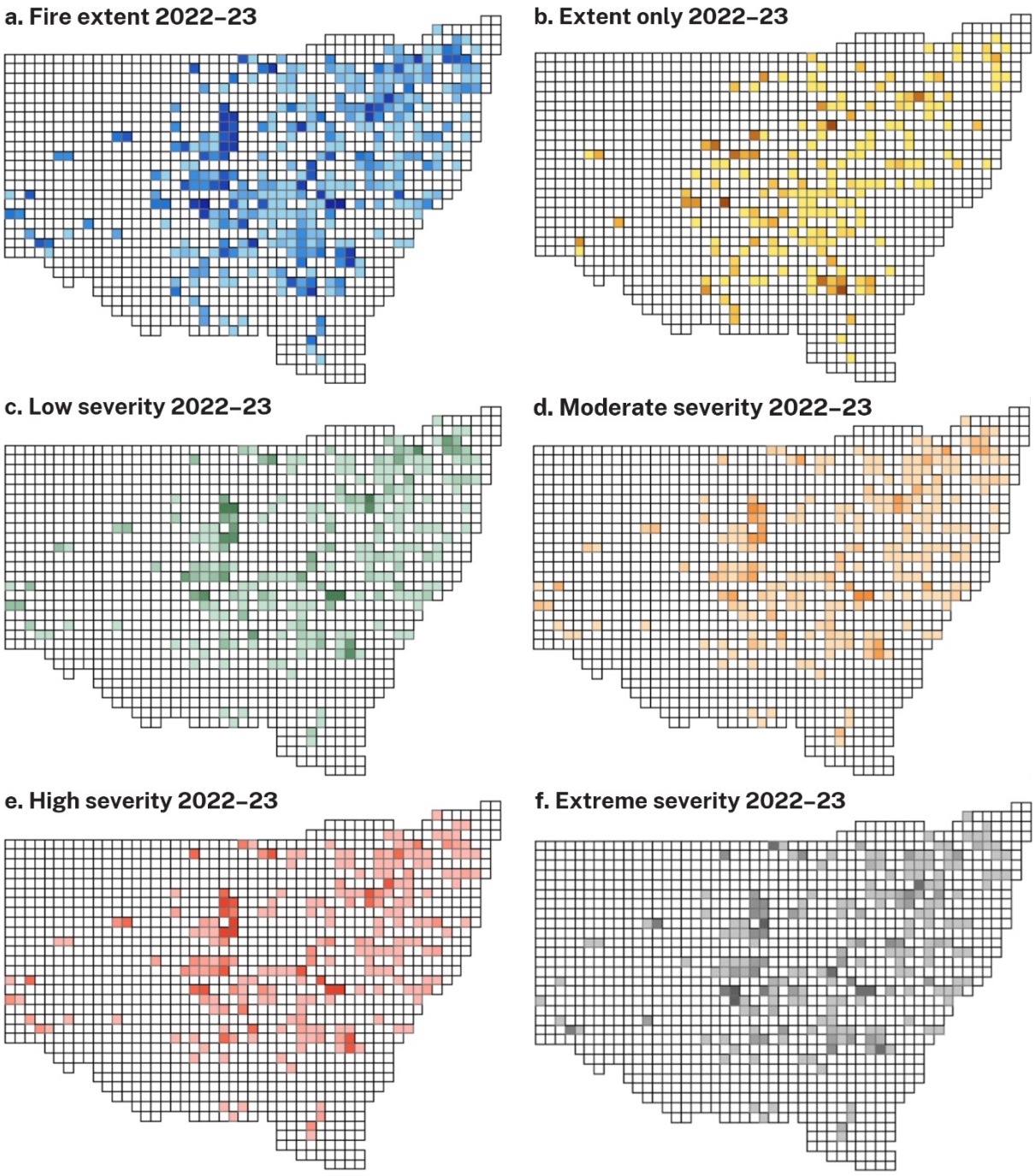

Figure 1 **Geographic distribution of fire extent and fire severity across New South Wales for the 2022–23 fire year: (a) fire extent, (b) extent only (grass fires), (c) low severity, (d) moderate severity, (e) high severity and (f) extreme severity**

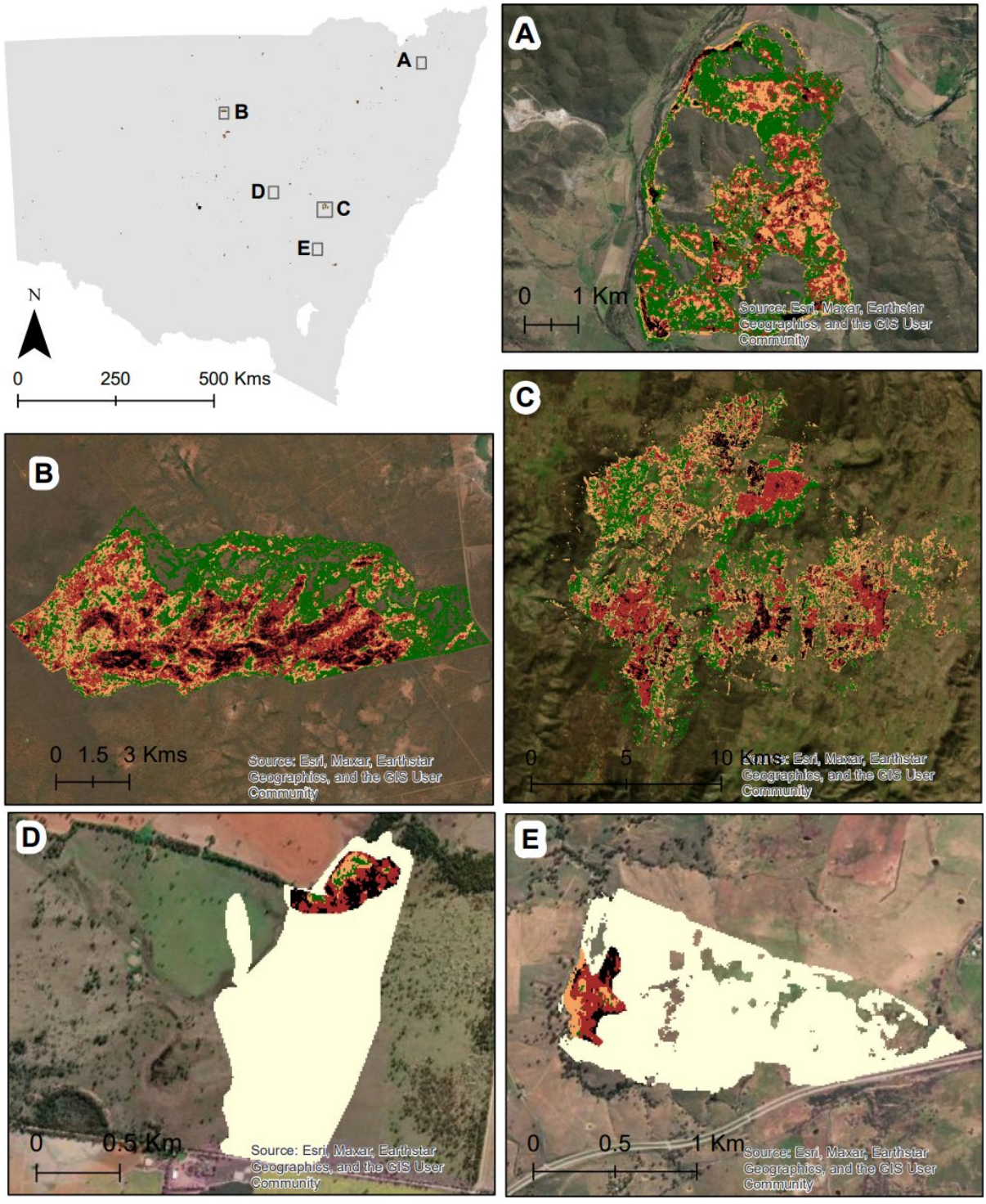

Figure 2 **The FESM mapping for 2022–23 with 5 map insets (A–E) of example fires from across the state**

Reporting breakdowns for the 2022–23 fire year

To help decision-makers and conservation efforts, NSW fire extent and severity are reported on in a variety of ways across land management and ecological units. The complete datasets are available on the SEED portal (see 'More information'). This section summarises NSW fire extent for 2022–23 across:

- local government areas (LGAs)
- Local Land Services (LLS) regions
- Interim Biogeographic Regionalisation for Australia (IBRA) bioregions
- lands managed by the NSW National Parks and Wildlife Service (NPWS)
- vegetation formations (Keith 2004)
- soil textures.

Fire extent across local government areas

The majority of the top 10 LGAs with the highest burnt area in 2022–23 were in central and western New South Wales (Figure 3). For the second consecutive year, Cobar LGA was in the top 10 LGAs with the highest burnt area. Cobar had 12,700 hectares (ha) burnt in 2021–22 and 15,400 ha burnt in 2022–23.

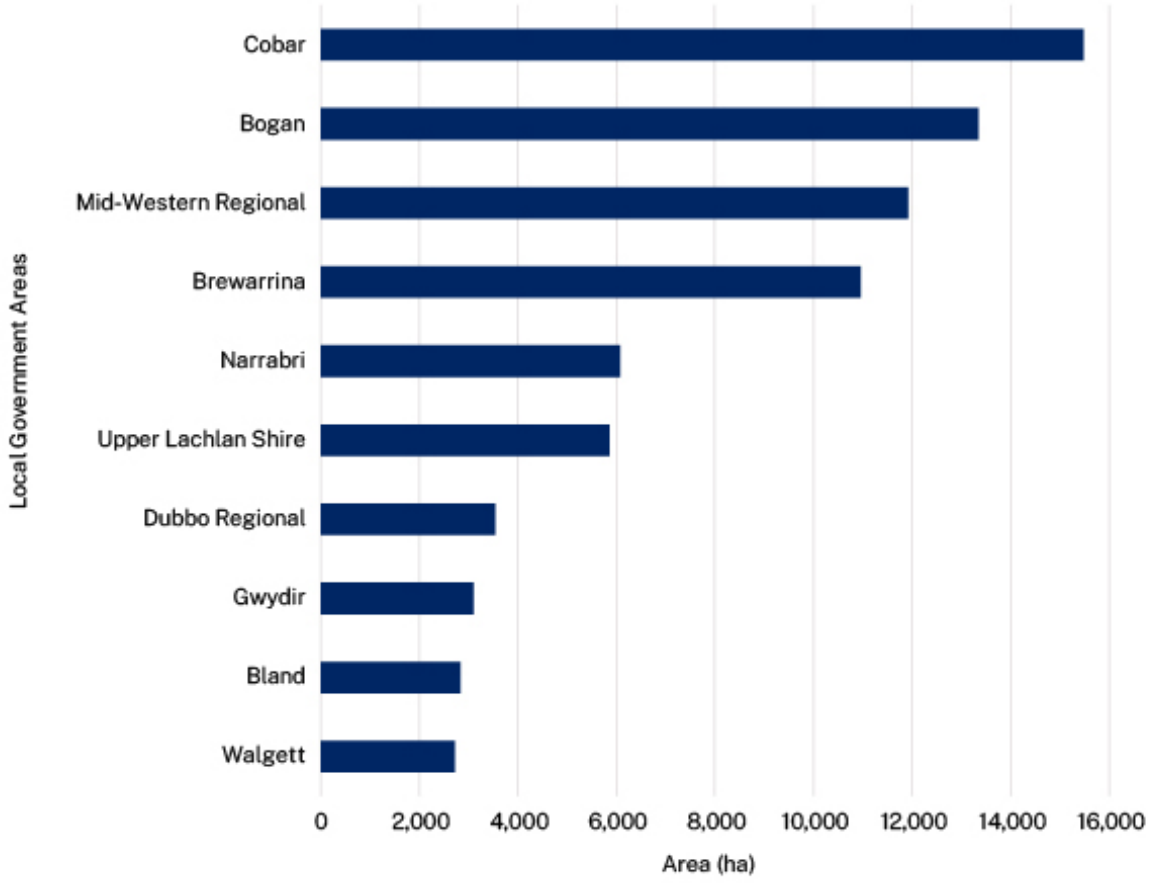

Figure 3 **Area burnt in each LGA in the 2022–23 fire year**
The top 10 LGAs with the highest burnt area have been included here.

Fire extent across Local Land Services regions

The Western LLS region had the greatest area burnt in New South Wales in 2022–23, for the second consecutive year (Figure 4).

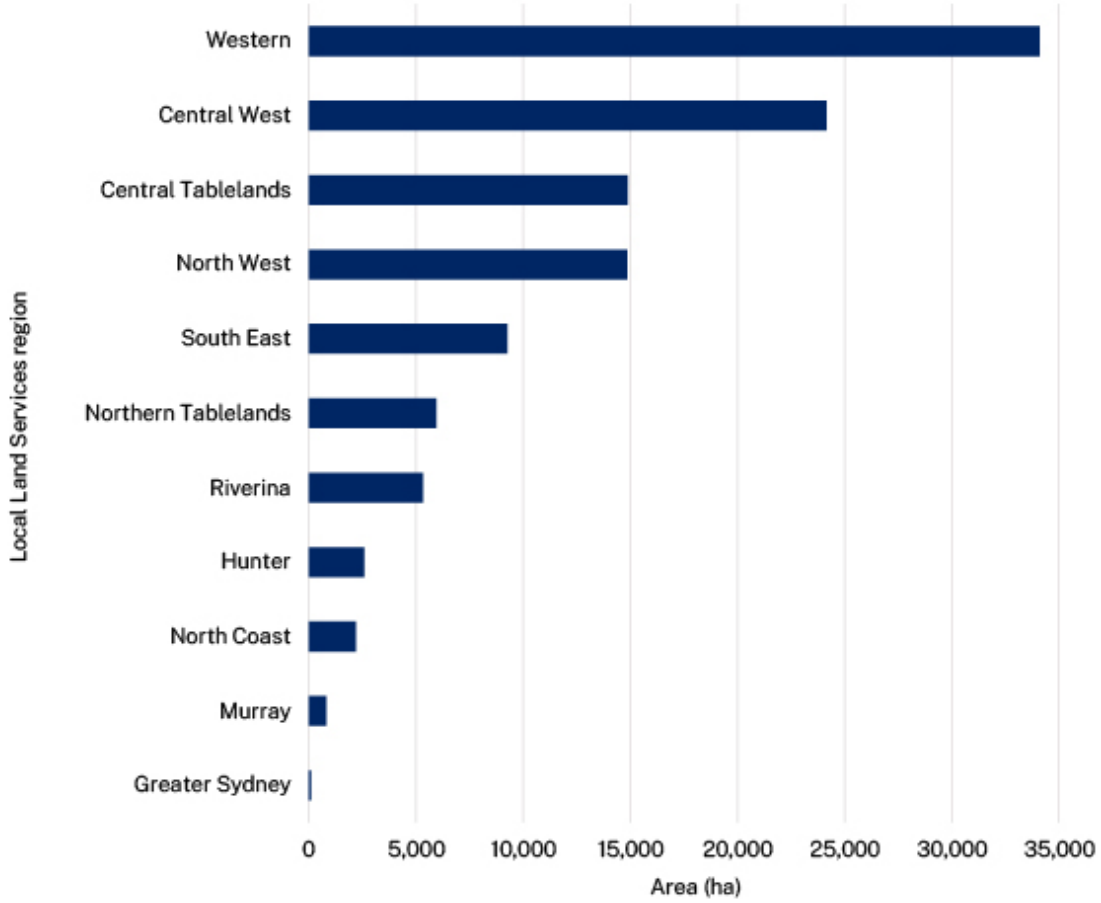

Figure 4 **Area burnt in each Local Land Service region in the 2022–23 fire year**
All LLS regions with burnt areas have been included here.

Fire extent across Interim Biogeographic Regionalisation for Australia bioregions

The Cobar Peneplain and South Eastern Highlands had more than triple and more than double the area burnt, respectively, compared to the rest of the IBRA regions (Figure 5). For the third consecutive year, the South East Corner and Australian Alps bioregions again had no fire activity in 2022–23, in sharp contrast to the previous fire year 2019–20 where almost 60% of the South East Corner and 30% of the Australian Alps bioregions were burnt.

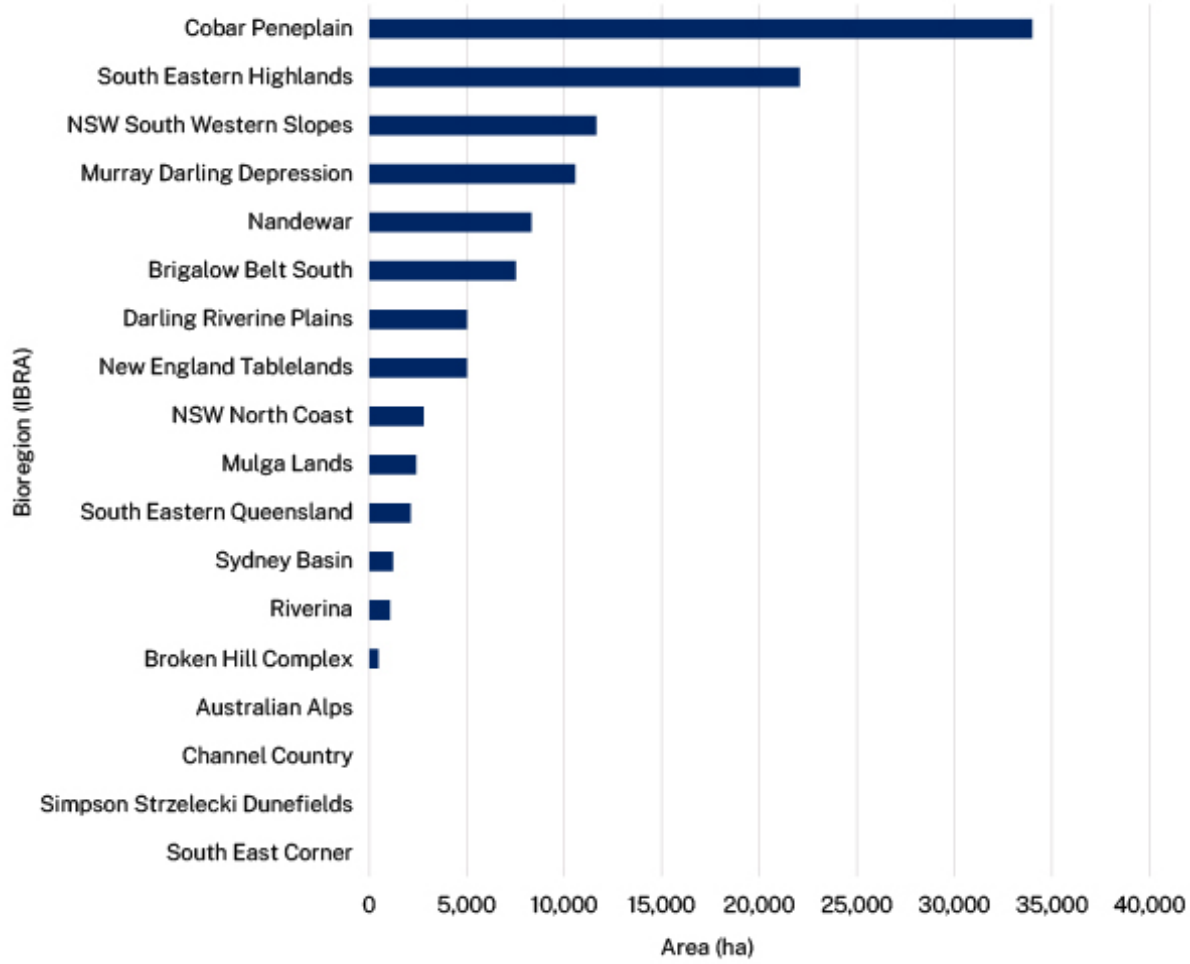

Figure 5 **Area burnt in each IBRA bioregion in the 2022–23 fire year**
All bioregions with burnt areas have been included here.

Fire extent across NPWS-managed lands

Nombinnie Nature Reserve (NR) had the largest burnt area across NPWS-managed lands in the 2022–23 fire year (Figure 6). Mount Kaputar National Park (NP) had 1,700 ha burnt (3% of the park), which was the largest burnt area of any park that was impacted during the extreme 2019–20 fire year, when 40% of Mount Kaputar NP was burnt. The area burnt in Mount Kaputar in 2022–23 did not overlap with the area burnt in 2019–20.

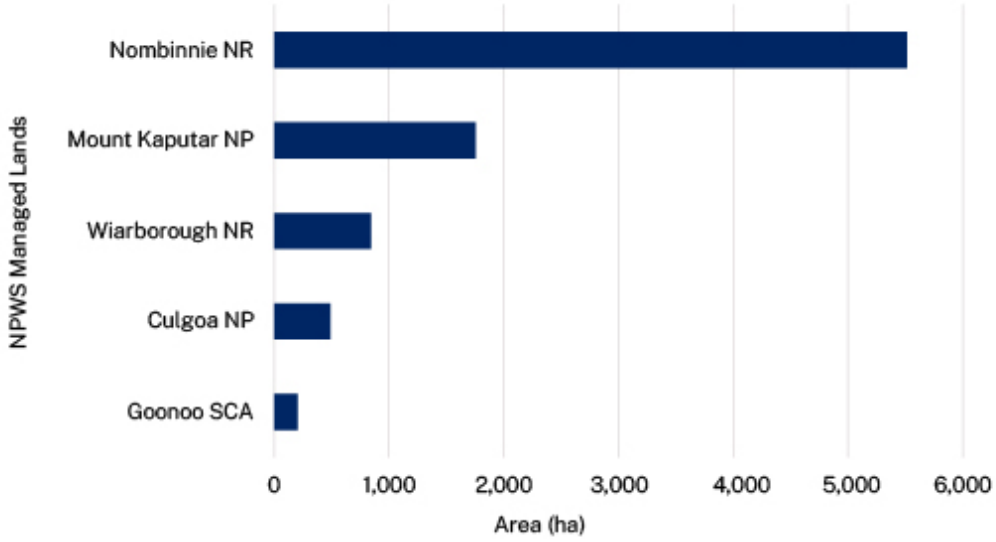

Figure 6 **Area burnt in NPWS-managed lands in the 2022–23 fire year**
NPWS-managed lands that had any fire activity have been included here.

Fire extent across NSW Keith vegetation formations

The vast majority of the area burnt in 2022–23 ocurred within cleared vegetation (i.e. non-native vegetation) and semi-arid shrubby woodlands (Figure 7). This was more than triple the area burnt in sclerophyll forest types and grassy woodland formations in 2022–23.

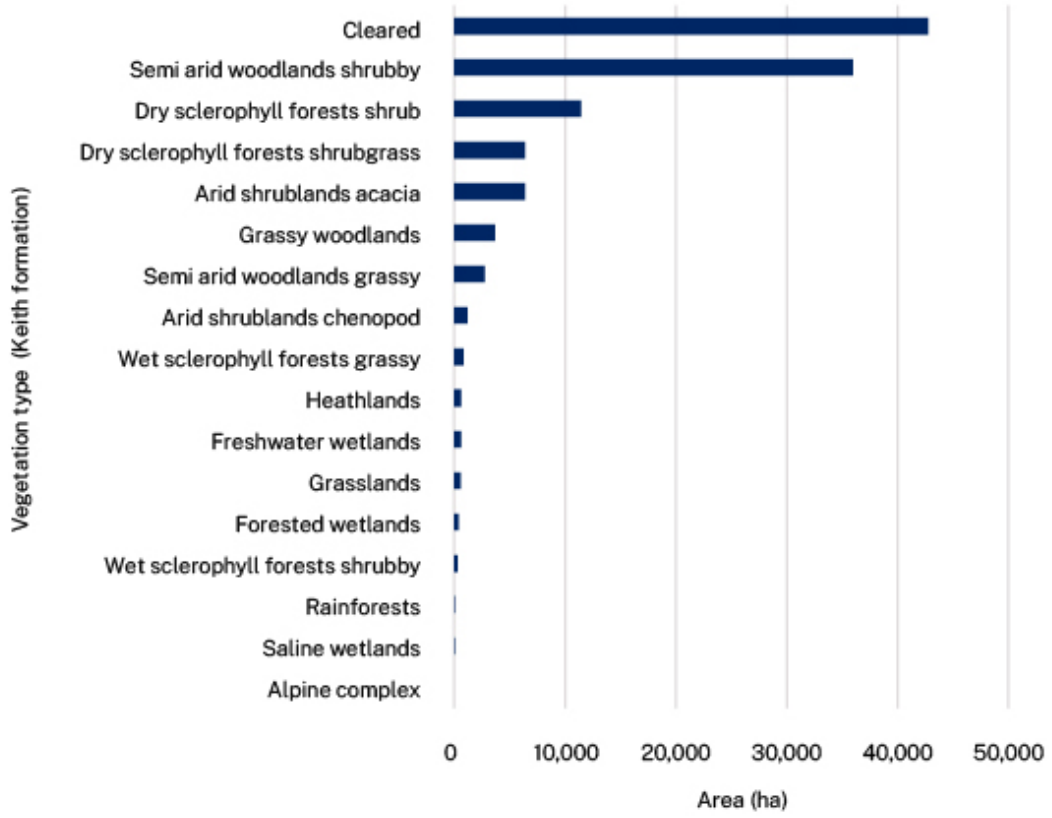

Figure 7 **Area of Keith vegetation formations burnt in the 2022–23 fire year**

Vegetation formations that had more than 1,000 hectares burnt have been included here.

Fire extent across soil texture types

Sandy loam had the highest area burnt in 2022–23 (Figure 8a), almost double that of clay loam with the next largest area burnt. Highly organic/peat soil texture types had the lowest area burnt for the second consecutive year (60 ha; Figure 8b). Soil texture classes with high organics or low clay percentages (e.g. highly organic, sandy loam and loose sand) are more vulnerable to damage following hot fires.

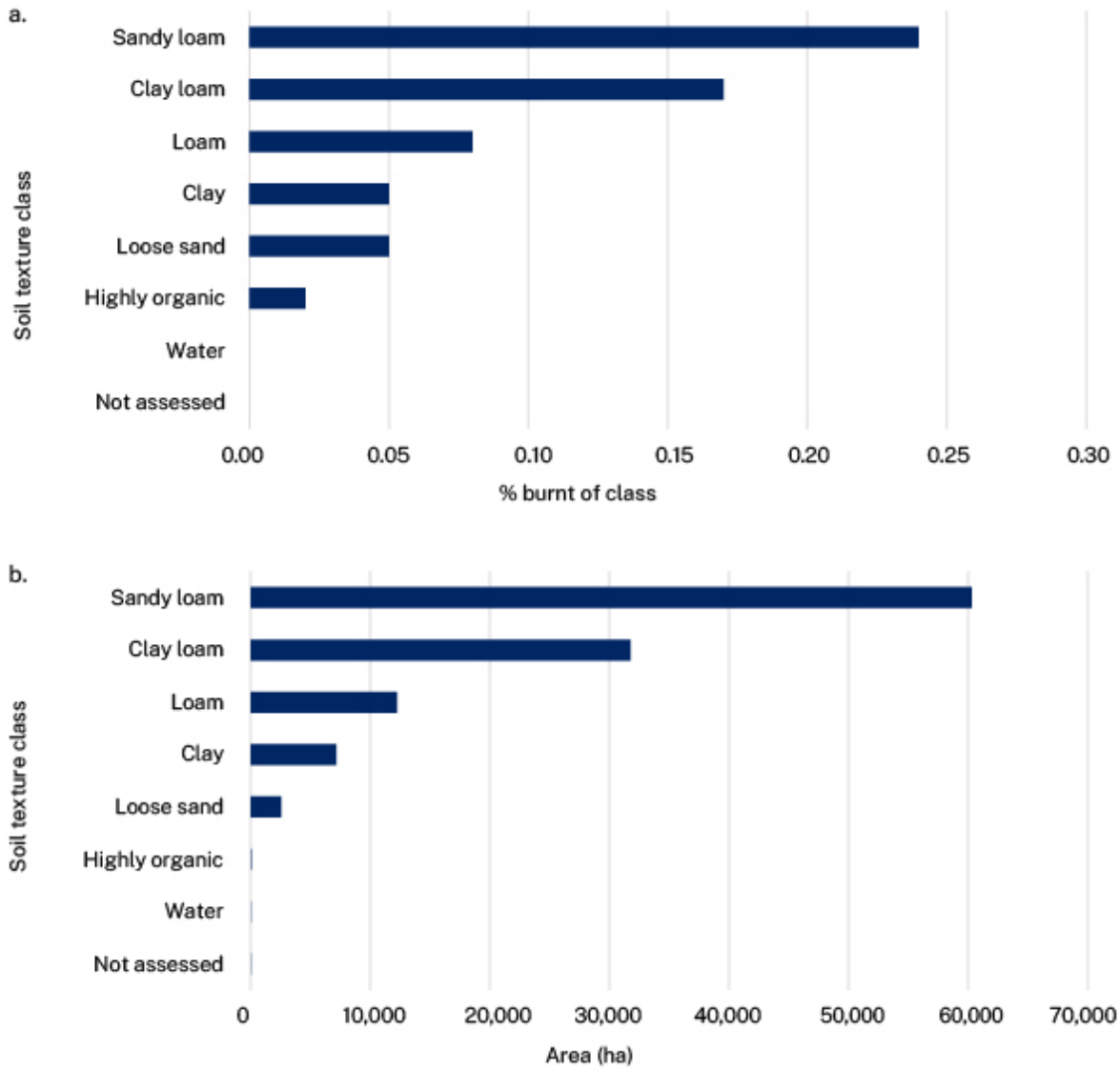

Figure 8 **Area burnt (a), and (b) proportion of class area burnt across soil texture classes in the 2022–23 fire year**

Comparison with previous years

This section provides a comparative assessment of the 2022–23 fire year with previous consecutive 5 fire years of statewide severity mapping: 2021–22, 2020–21, 2019–20, 2018–19 and 2017–18. Future reports will compare a rolling window of the study year with the previous 5 years.

The 2022–23 fire year had much higher fire activity overall, compared to the previous 2 years since the extreme 2019–20 fire year (Figure 9a and Figure 10). A large proportion of the area burnt in 2022–23 occurred in western parts of the state, while fire activity in coastal areas was generally very low. This in is stark contrast to the very high fire activity along the east coast in the 2019–20 fire year (Figure 9d). Fire activity in the south-east coast and Alpine region of the state was markedly low in 2022–23 compared with the fire years from 2017–18 to 2019–20 (Figure 9d–f).

The proportion of each severity class within the fire extent differed between the fire years (Figure 11). The 2022–23 fire year had a more even proportion across the severity classes, from 22–29%, which is most similar to the 2019–20 fire year. The refinement of the FESM processing method in 2022–23 to include extent only in grassy areas is likely to have reduced the error of applying a severity classification predominantly trained on forested ecosystems to grass fires.

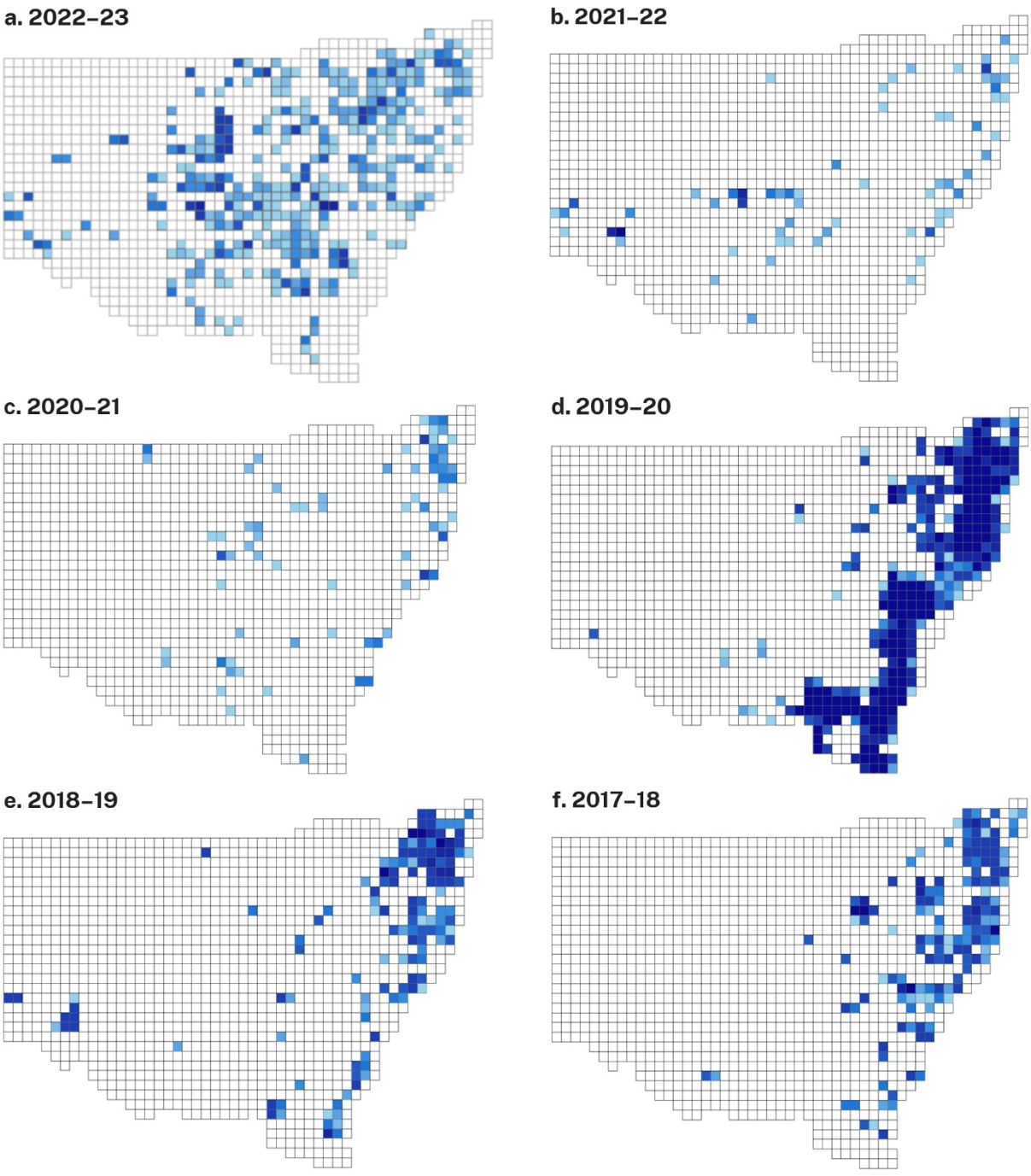

Figure 9 **Geographic distribution of fire extent (area burnt) across New South Wales for the 2022–23 fire year (a), and previous fire years: (b) 2021–22, (c) 2020–21, (d) 2019–20, (e) 2018–19 and (f) 2017–18**

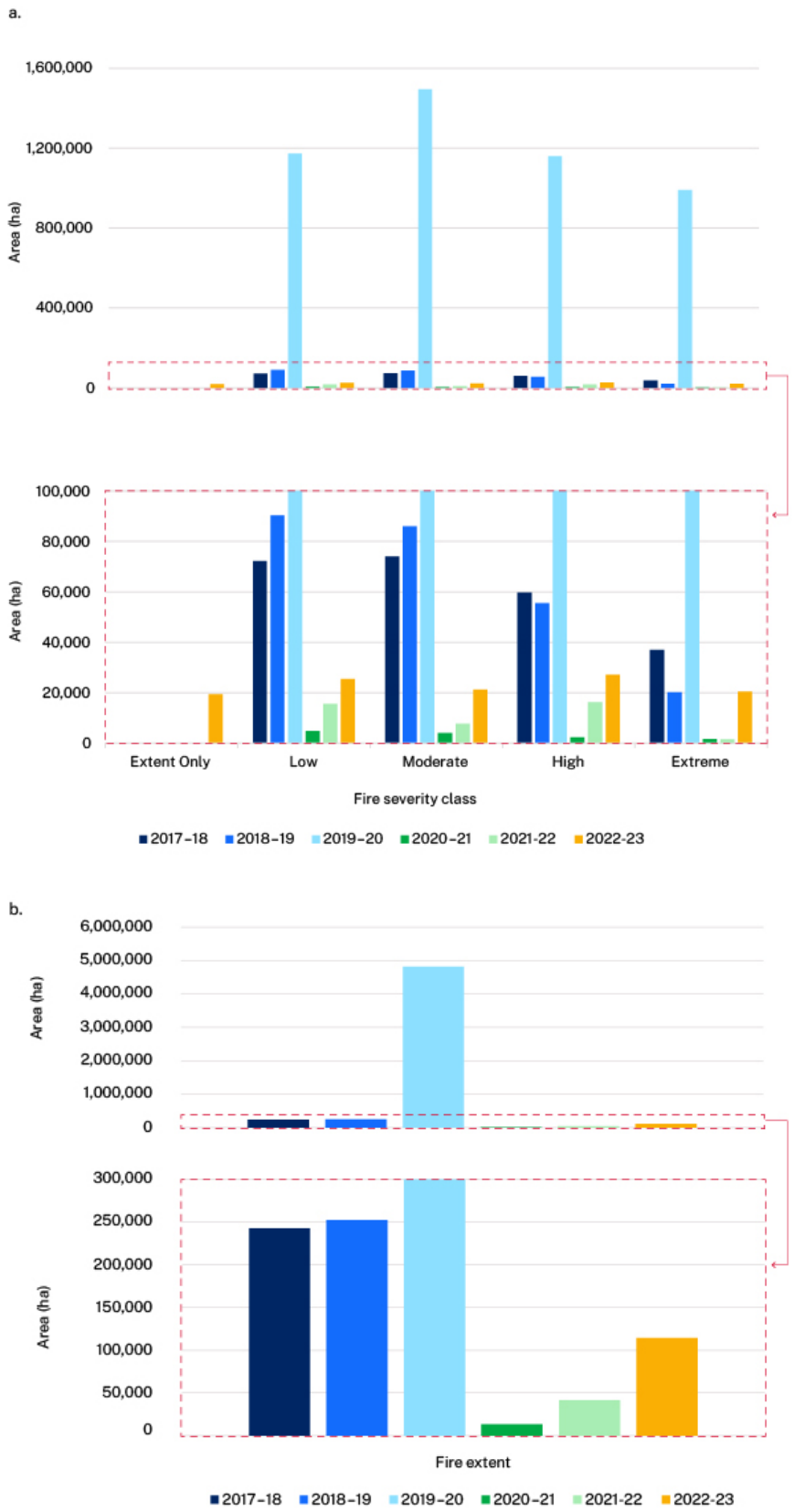

Figure 10 **Comparison of (a) fire severity, and (b) fire extent between 2022–23 and the previous 5 fire years**

Note the 2 panels of each figure are on different scales, with the lower panel excluding 2019–20 data above 100,000 and 300,000 hectares for a and b respectively. Extent only (i.e. grass fires) is only available from 2022–23 onwards.

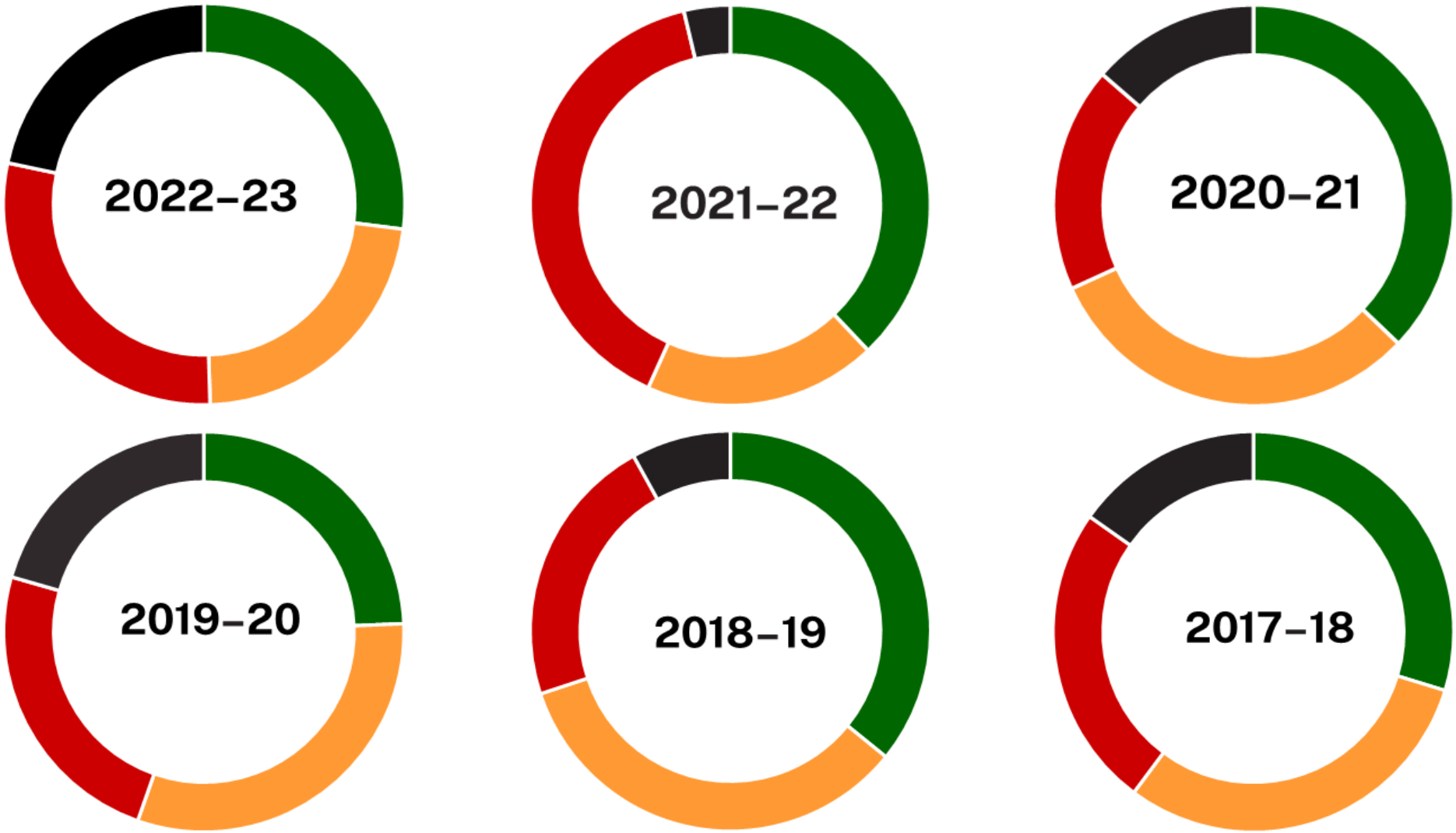

Figure 11 **Comparison of the proportion of each severity class in New South Wales in 2022–23, and the previous 5 fire years: 2021–22, 2020–21, 2019–20, 2018–19, 2017–18**

More information

Webpages and fact sheets

- Landcover science, NSW Department of Planning and Environment
- Fire extent and severity maps, NSW Department of Planning and Environment
- Recovering from the 2019–20 fires, NSW Department of Planning and Environment
- Supporting fire management with the fire extent and severity maps: Fire mapping by machine learning fact sheet, NSW Department of Planning and Environment

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 2022–23 fire year, along with results from previous years, are available on the Fire extent and severity maps webpage

References

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