Fire extent and severity mapping

Report for the 2021–22 fire year

Department of Planning and Environment

NSW GOVERNMENT

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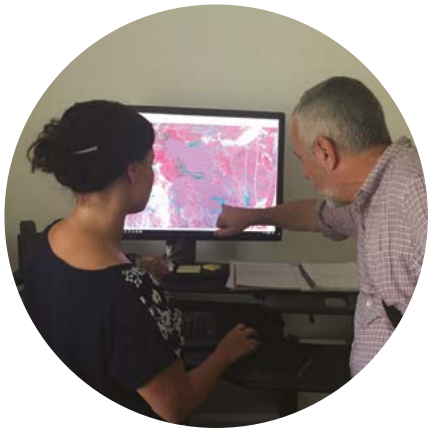
Contents



List of tables

List of figures

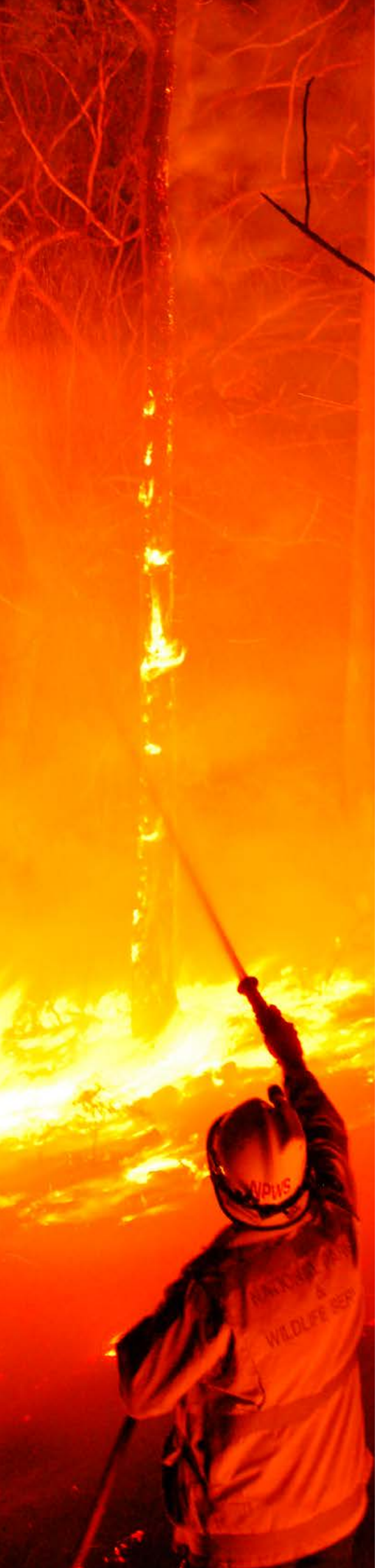
Introduction

Information about the severity of fire on the landscape is critical for understanding the relationship between fuels and fire behaviour, as well as 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 continuing 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 through 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 support us in understanding 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 analyses for the 2021–22 fire year; 2 years after the black summer of 2019–20. This is the third report in the series. Previous reports cover the fire years 2017–18, 2018–19 and 2019–20 (DPIE 2021), as well as the 2016–17 and 2020–21 fire years (DPE 2022). Future annual reports will be issued routinely in August each year and will cover the most recent fire year. As such, the next FESM annual report for 2022–23 will be released in August 2023.

This summary report is accompanied by a data spreadsheet for the 2021–22 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 (links to webpages are provided in the 'More information' section at the end of this report). Our Recovering from the 2019–20 fires website also includes information about understanding the effects of the extreme 2019–20 season of mega fires, what influences fire regimes and climate change, and links to current research being undertaken through the Bushfire Risk Management Research Hub.



How the FESM 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 (Gibson et al. 2020). The FESM fire severity classes are described in Table 1.

FESM Fire severity classification

Severity class	Description	Percentage foliage fire affected
Unburnt	Unburnt surface with green canopy	0% canopy and understorey burnt
Low	Burnt understorey with unburnt canopy	>10% burnt understorey >90% green canopy
Moderate	Partial canopy scorch	20–90% canopy scorch
High	Complete canopy scorch / partial canopy consumption	>90% canopy scorched <50% canopy biomass consumed
Extreme	Complete 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. 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.

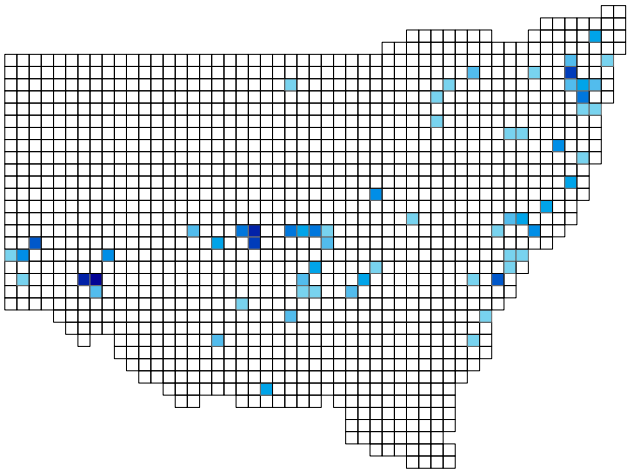
Fires mapped from the 2017–18 fire year and later, including those in this report, use Sentinel 2 satellite imagery, while fires mapped in the 2016–17 fire year or earlier use imagery from the Landsat platform. Although Landsat has a lower resolution than Sentinel 2, and the FESM system uses different algorithms and training data for each sensor, accuracy and area calculations are comparable between severity classes mapped by Sentinel 2 and Landsat algorithms. A comprehensive assessment of the differences in fire extent and severity mapping between sensor algorithms is provided in the previous report (DPE 2022).

NSW statewide assessment of fire extent and severity for the 2021–22 fire year

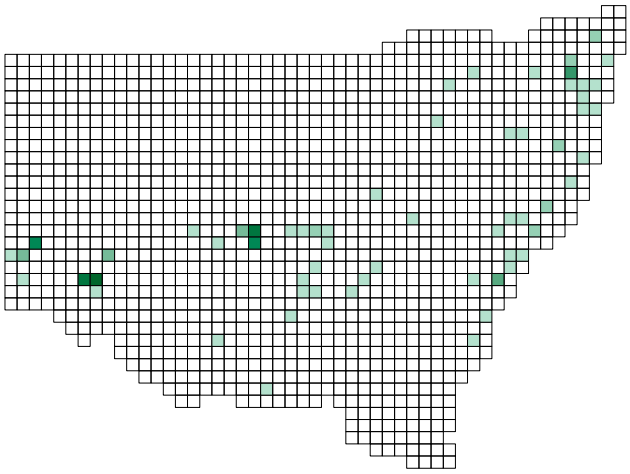
The fire season of 2021–22 had relatively low fire activity, with 41,336 ha burnt statewide. The high rainfall and relatively mild temperatures seen in 2020–21 continued, with ongoing La Niña weather patterns. Parts of New South Wales experienced prolonged rainfall and flooding. Weather conditions in the 2021–22 fire year once again led to low flammability of fuels across much of New South Wales.

A high proportion of total fire occurred inland, in the west of the state (Figure 1). This pattern may have resulted from the accumulation of grassy fuels caused by high spring rainfall followed by warm summer temperatures in the west of the state. Meanwhile, very high rainfall and flooding across coastal parts of New South Wales during the 2021–22 fire year likely suppressed fire activity in coastal areas. The observed pattern fits with expected fire regimes in wet years. In woodland communities (which occur broadly in western New South Wales), fire activity is promoted by the growth of herbaceous fuels; whereas in forest communities (which dominate coastal parts of the state), fire activity is limited by fuel moisture (Bradstock 2010).

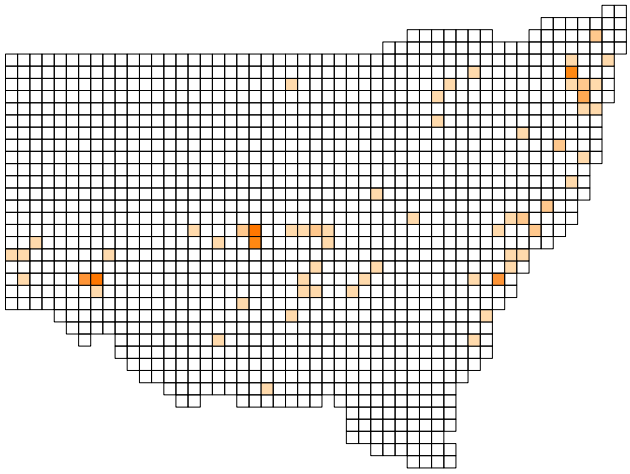
Figure 2 provides examples of FESM for 5 fires that occurred during the 2021–22 fire year in different parts of the state. It shows that much of the fire extent for the 2021–22 fire year resulted from 2 large fires in the west of the state.



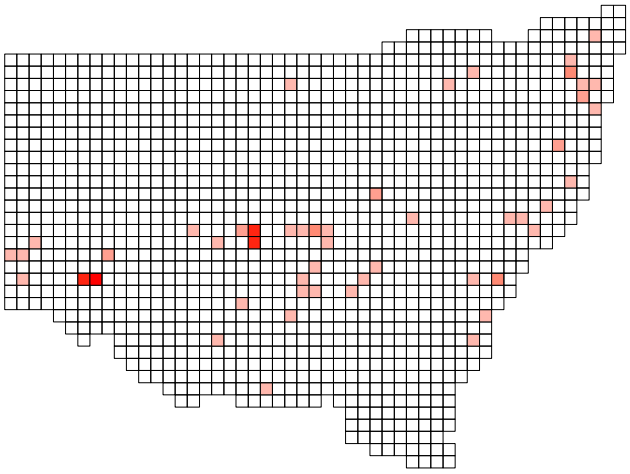
a. Fire extent 2021–22



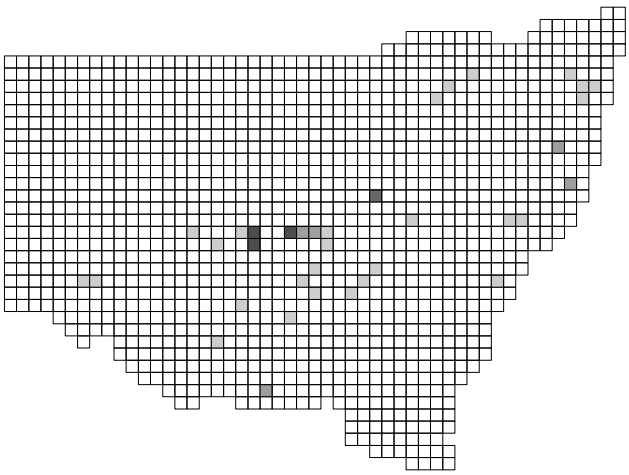
b. Low severity 2021–22



c. Moderate severity 2021–22



d. High severity 2021–22



e. Extreme severity 2021–22

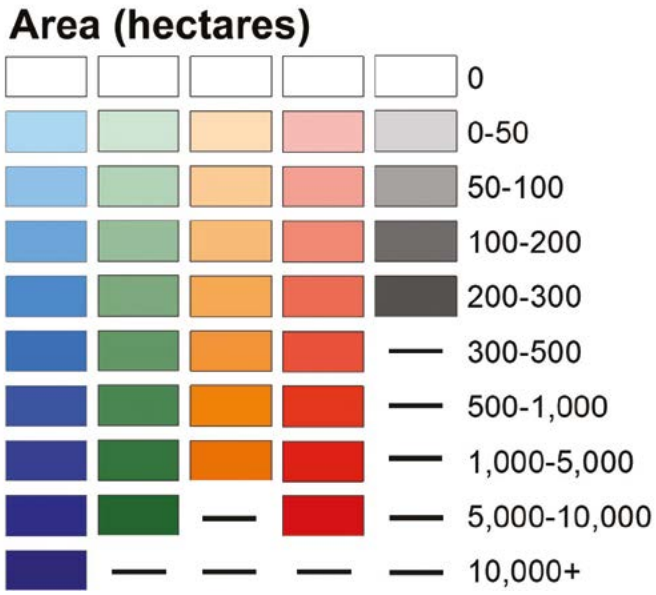


Figure 1 Geographic distribution of fire extent and fire severity across New South Wales for the 2021–22 fire year: (a) fire extent, (b) low severity, (c) high severity, (d) moderate severity and (e) extreme severity

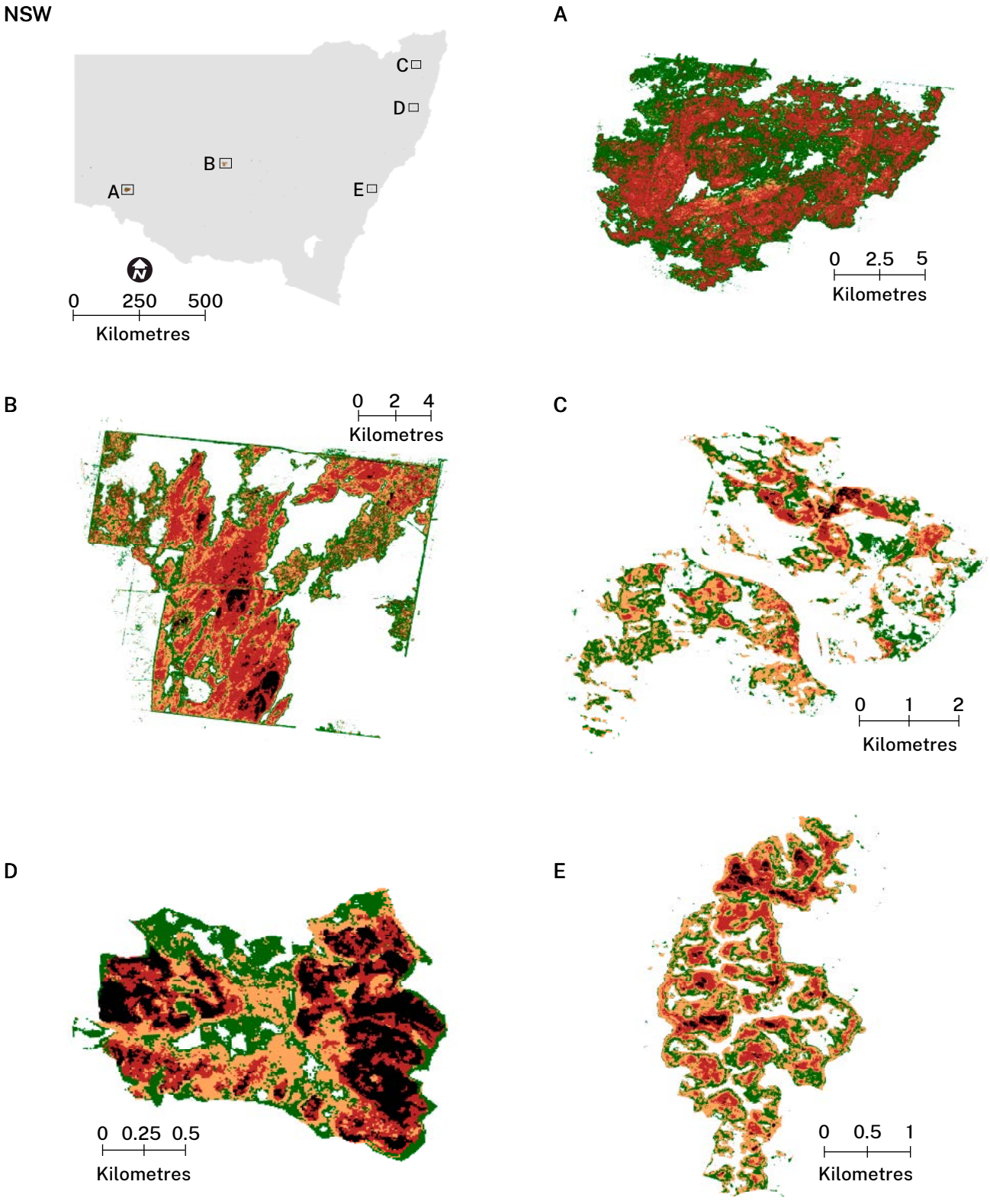


Figure 2 Fire extent and severity mapping for 2021–22 with 5 map insets (A–E) of example fires from across the state

Reporting breakdowns for the 2021–22 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. This section summaries NSW fire extent for 2021–22 across:

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

Fire extent across local government areas

Wentworth and Cobar LGAs in the west of the state had the highest burnt area in 2021–22, with more than 10,000 ha burnt in each LGA (Figure 3). Clarence Valley on the North Coast had the next highest burnt area, although this was under 2,000 ha. Hornsby LGA had the largest percentage of area burnt at 1.75% of the LGA, with a burnt area of 881 ha.

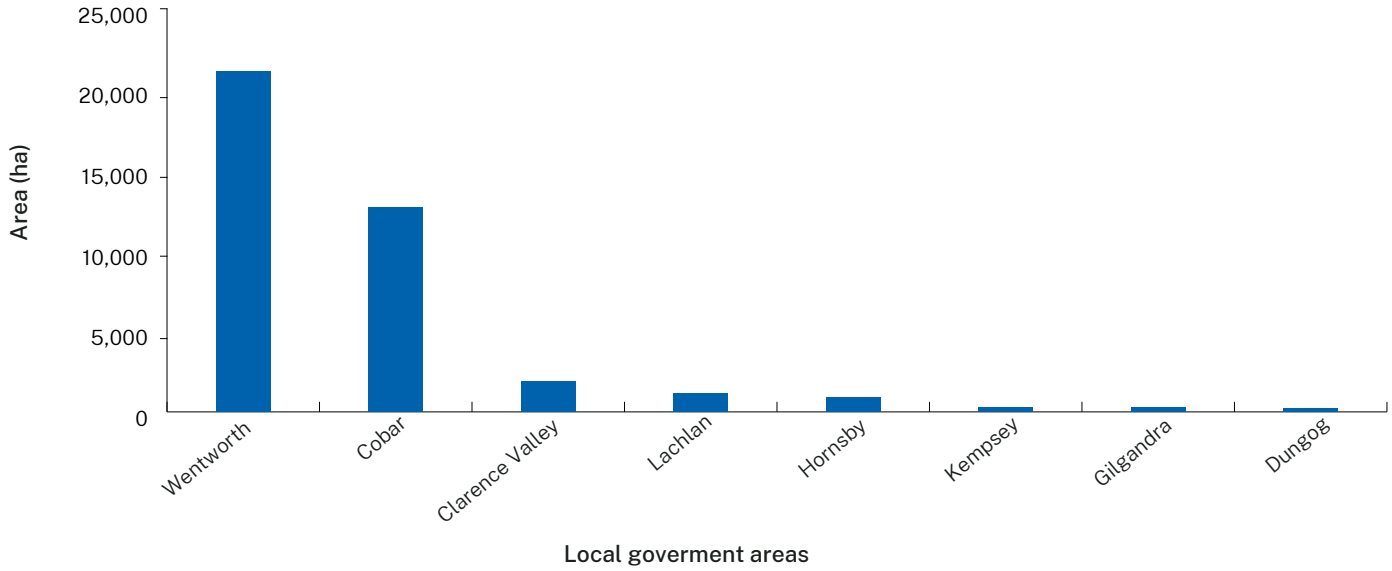


Figure 3 The area burnt in each local government area (LGA) in the 2021–22 fire year. LGAs that had more than 200 ha burnt have been included here

Fire extent across Local Land Services regions

The Western LLS region had the greatest area burnt in New South Wales in 2021–22, and this was much higher than any other region (Figure 4).

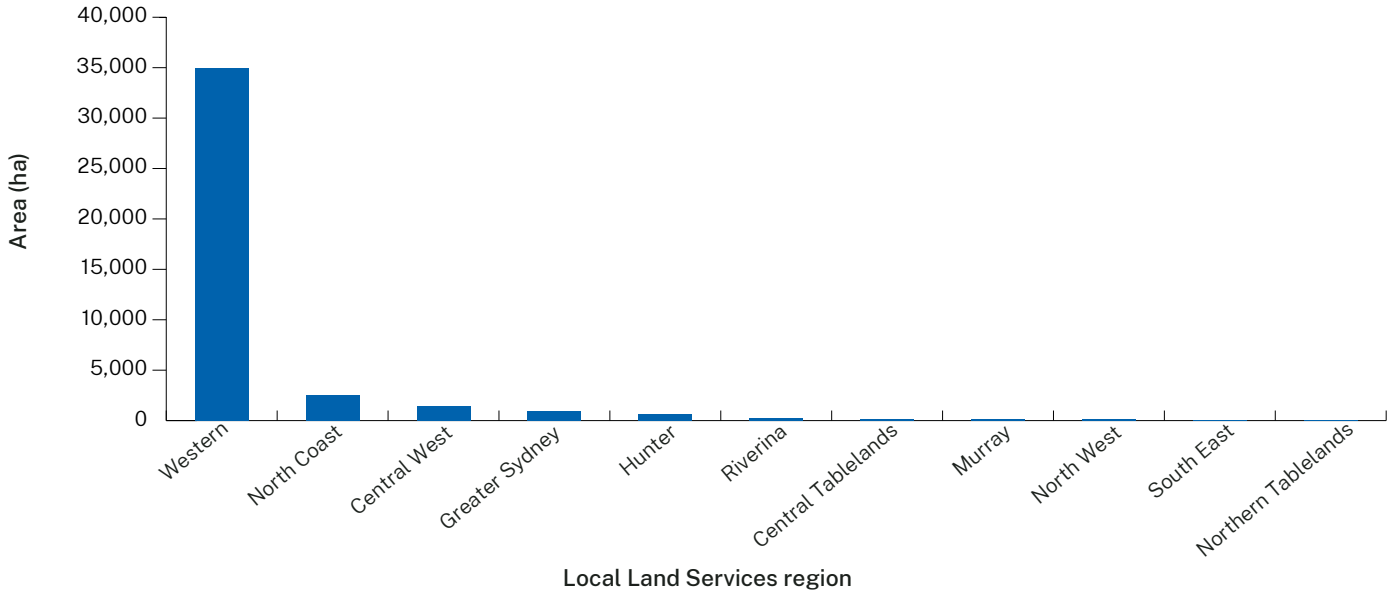


Figure 4 The area burnt for each Local Land Services (LLS) region in the 2021–22 fire year. All LLS regions with burnt areas have been included here

Fire extent across tenure

Lease land had the greatest area burnt in 2021–22, followed by freehold land and Crown land (Figure 5). National park and state forest lands had very low areas burnt in the 2021–22 fire year.

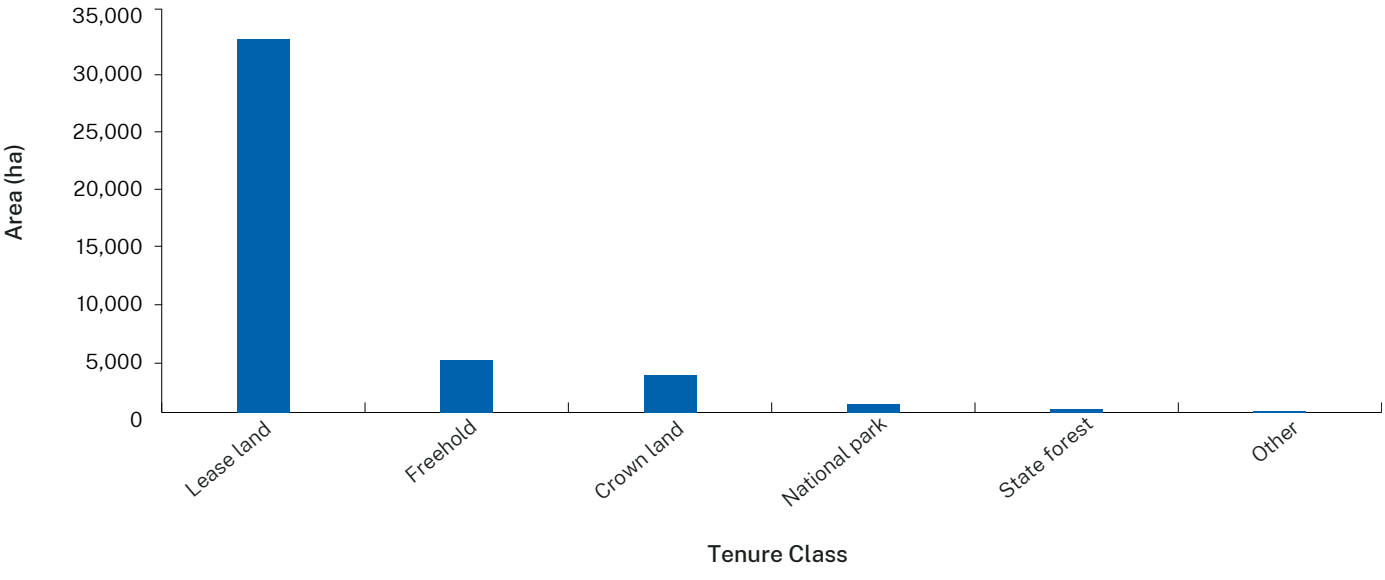


Figure 5 The area burnt for each tenure class in the 2021–22 fire year. All tenures have been included here

Fire extent across Interim Biogeographic Regionalisation for Australia bioregions

The NSW Murray Darling Depression Bioregion had the largest area burnt in 2021–22, followed by Cobar Peneplain (Figure 6). As in 2020–21, the South East Corner and Australian Alps bioregions again had no fire activity in 2021–22, in sharp contrast to the 2019–20 fire year where almost 60% of the South East Corner and over 30% of the Australian Alps bioregions were burnt.

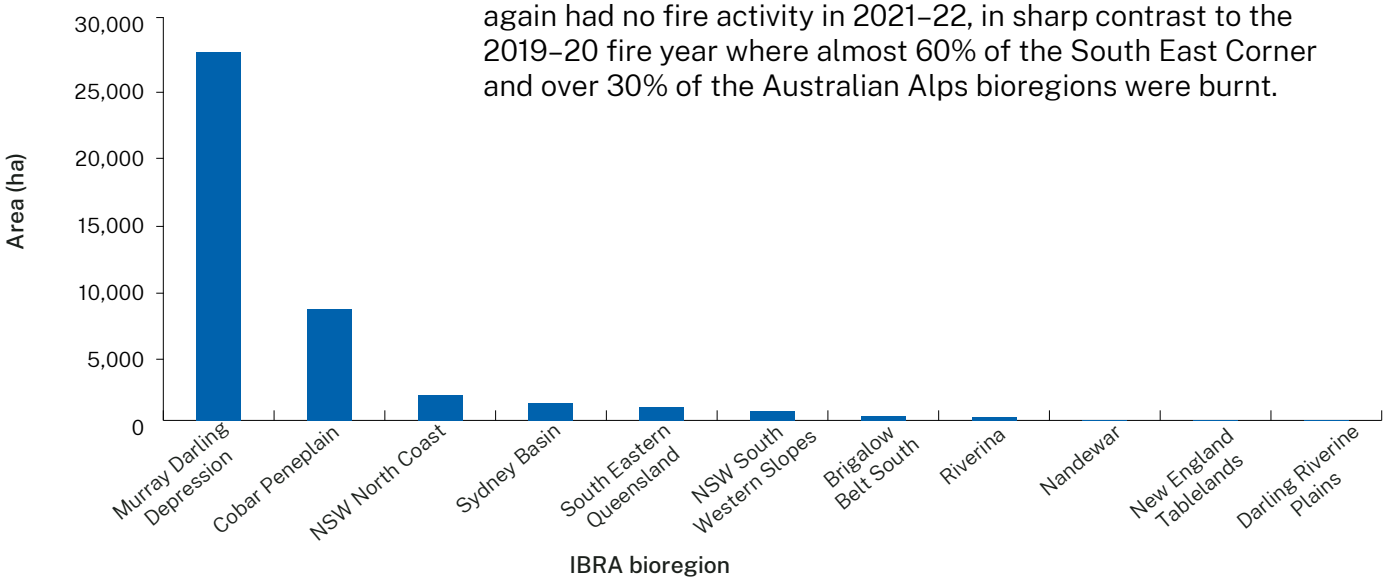


Figure 6 The area burnt in each Interim Biogeographic Regionalisation for Australia (IBRA) bioregion in the 2021–22 fire year. All bioregions with burnt areas have been included here

Fire extent across NPWS managed lands

There was very low fire activity across NPWS managed lands in the 2021–22 fire year. Mungo National Park had the largest wildfire in 2021–22, although the area burnt was only 255 ha or 0.2% of the park.

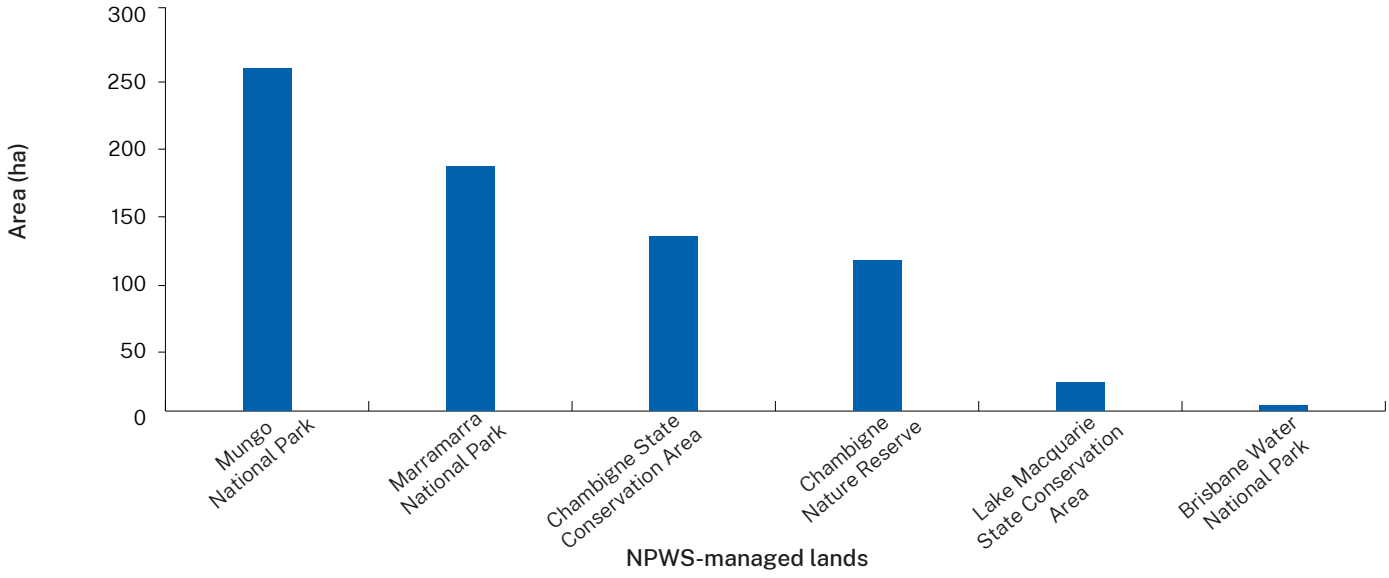


Figure 7 The area burnt in NPWS-managed lands in the 2021–22 fire year. All NPWS-managed lands with burnt areas have been included here

Fire extent across NSW Keith vegetation formations

The vast majority of the area burnt in 2021–22 ocurred within semi arid shrubby woodlands (Figure 8), however this represented only 0.3% of that vegetation formation in the state. Cleared vegetation (i.e. non native vegetation) had the second largest area burnt in 2021–22. All sclerophyll forest types had less than 2,000 ha burnt in 2021–22.

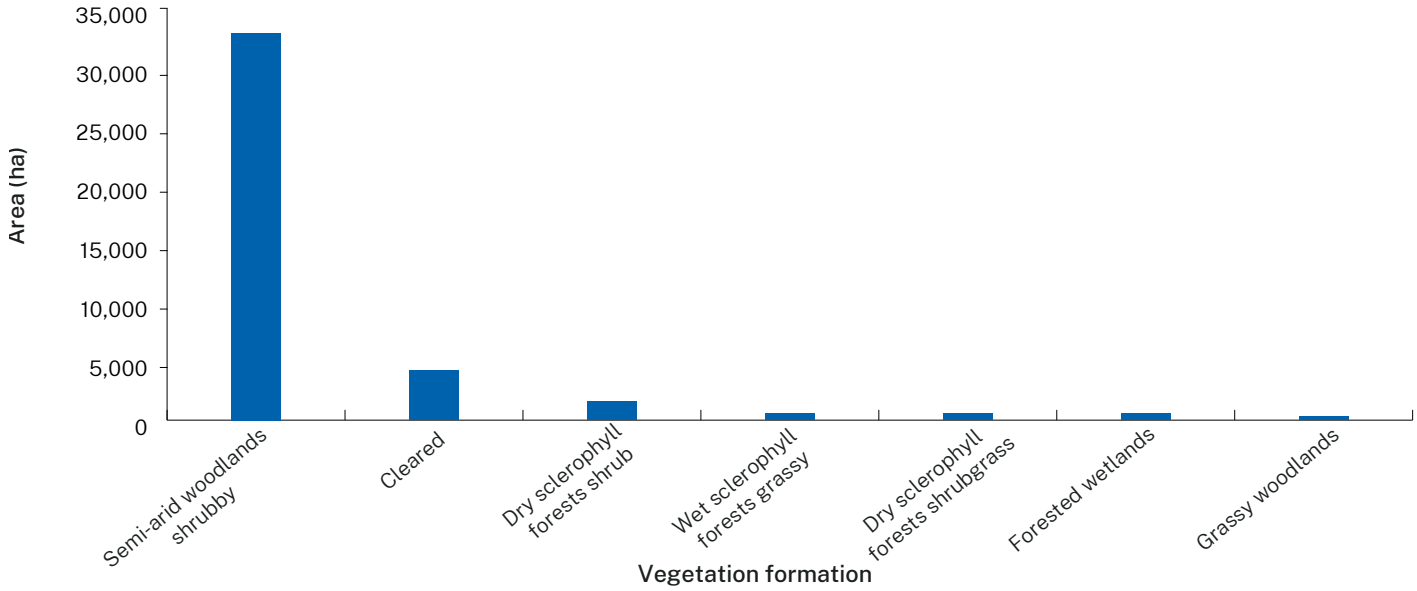
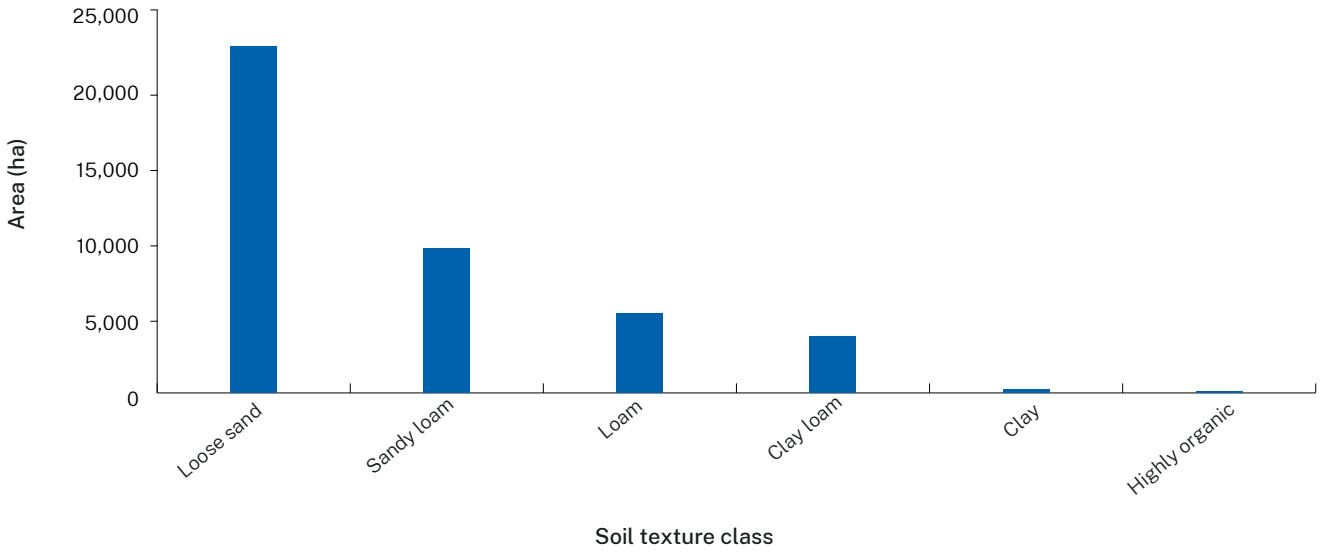


Figure 8 The area of Keith (2004) vegetation formations burnt in the 2021–22 fire year. Vegetation formations that had more than 200 ha burnt have been included here

Fire extent across soil texture types

Loose sand and sandy loam had the greatest area burnt in 2021–22 (Figure 9a). Highly organic/peat soil texture types had the lowest area burnt (123 ha), but this represented the second greatest proportion of class area burnt, at 0.05% (Figure 9b). Soil texture classes with high organics or low clay percentages (for example highly organic, sandy loam and loose sand) are more vulnerable to damage following hot fires.

a.



b.

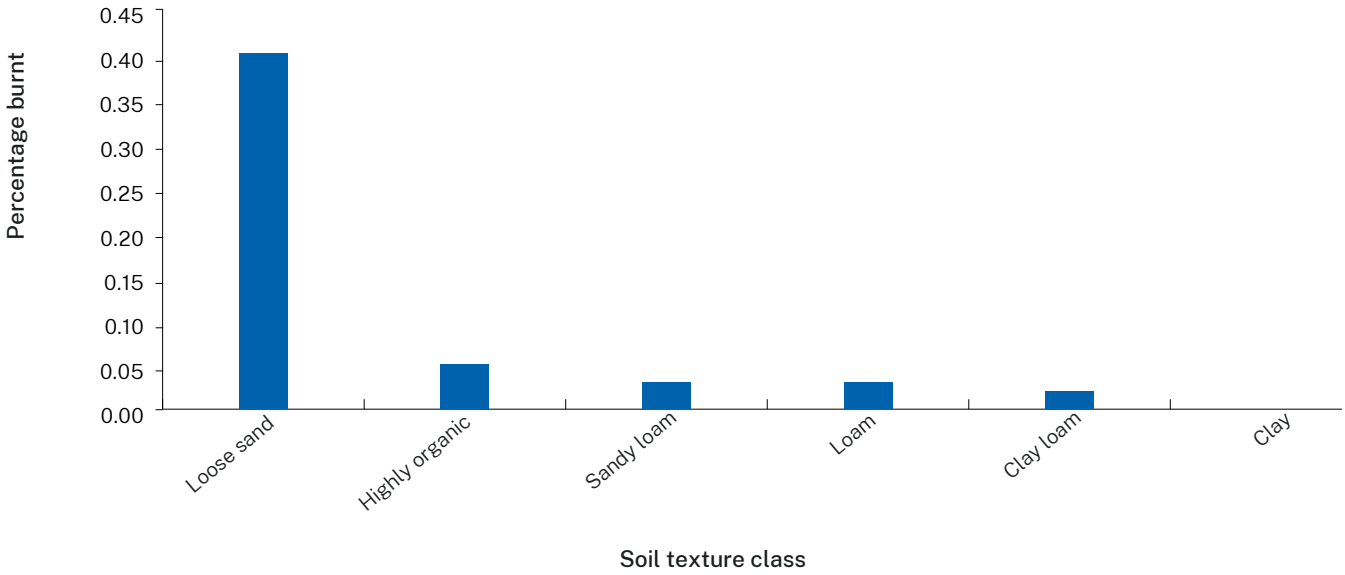


Figure 9 The area burnt (a) and proportion of class area (b) across soil texture classes in the 2021–22 fire year

Comparison with previous years

This section compares the 2021–22 fire year with the previous 5 fire years, including 2020–21, 2019–20, 2018–19, 2017–18 and 2016–17. This provides a comparative assessment of the current year with the previous five consecutive years of statewide severity mapping. Future reports will compare a rolling window of the study year with the previous five years.

The 2021–22 fire year had low fire activity overall, as did the previous fire year of 2020–21 (Figure 10). A large proportion of the area burnt in 2021–22 resulted from fires in western parts of the state, while fire activity in coastal areas was very low. This in is stark contrast to the very high fire activity along the east coast in the 2019–20 fire year. Fire activity in the south east of the state was markedly lower in 2021–22 compared with earlier fire years.

The proportion of each severity class within the fire extent differed between the fire years (Figure 11). The 2021–22 fire year had the lowest proportions of both exteme and moderate severity compared with other years, while the proporiton of high severity was the greatest across the six fire years. The proportion of low severity was similar to that in the previous fire year (2020–21). The total burnt area in 2021–22 was relatively small (Figure 12) and was largely dominated by 2 fires which occured in semi arid woodland in the west of the state. These events strongly influenced severity proportions for the year. The largest proportion of extreme severity and the smallest proportion of low severity occurred in 2019–20 (Figure 11), where the total area burnt was extremely large (Figure 12) and severity proportions were derived from many fire events, predominantly in coastal forests.

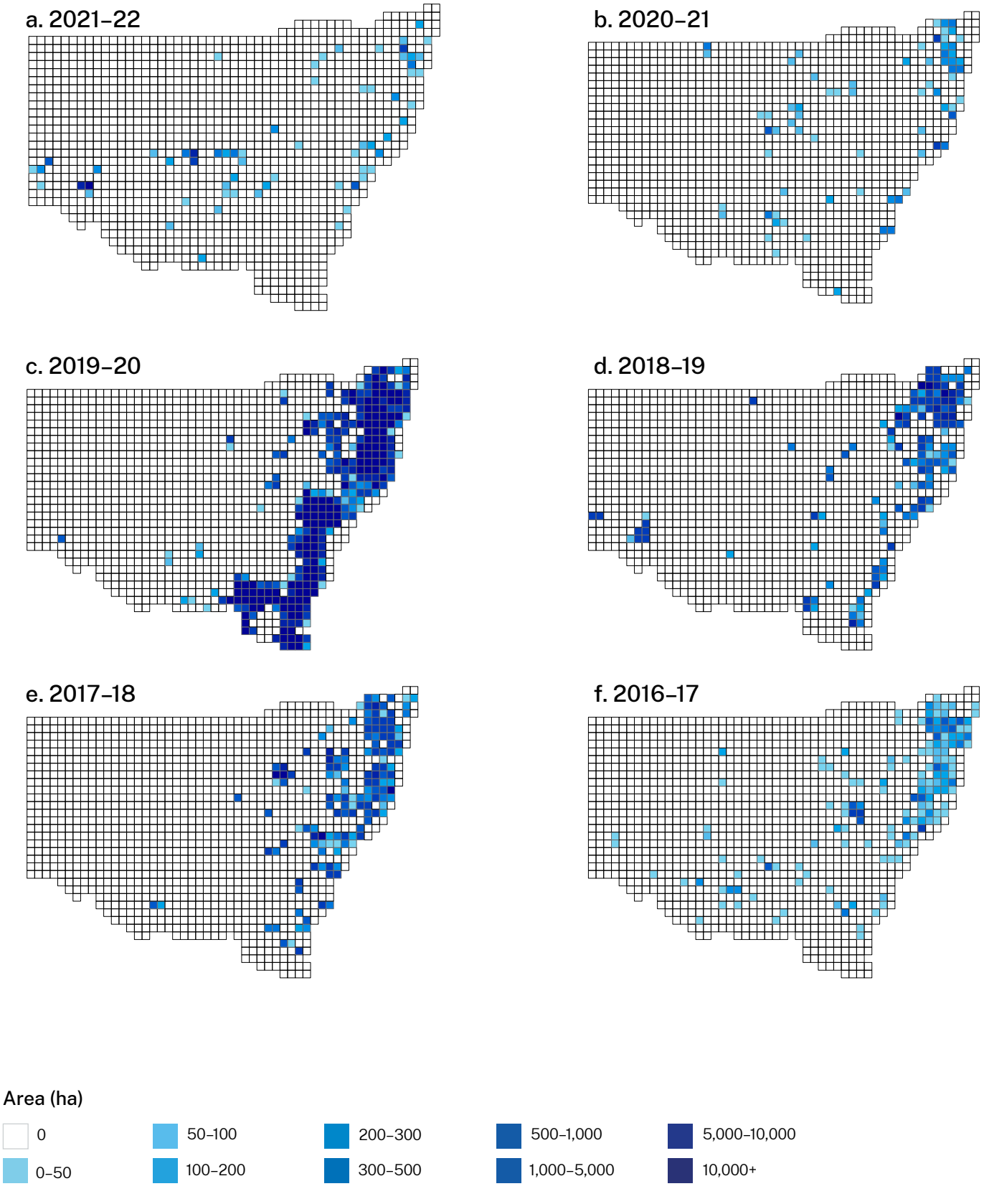


Figure 10 Geographic distribution of fire extent (area burnt) across New South Wales for the 2021–22 fire year (a), and previous fire years; (b) 2020–21, (c) 2019–20, (d) 2018–19, (e) 2017–18 and (f) 2016–17

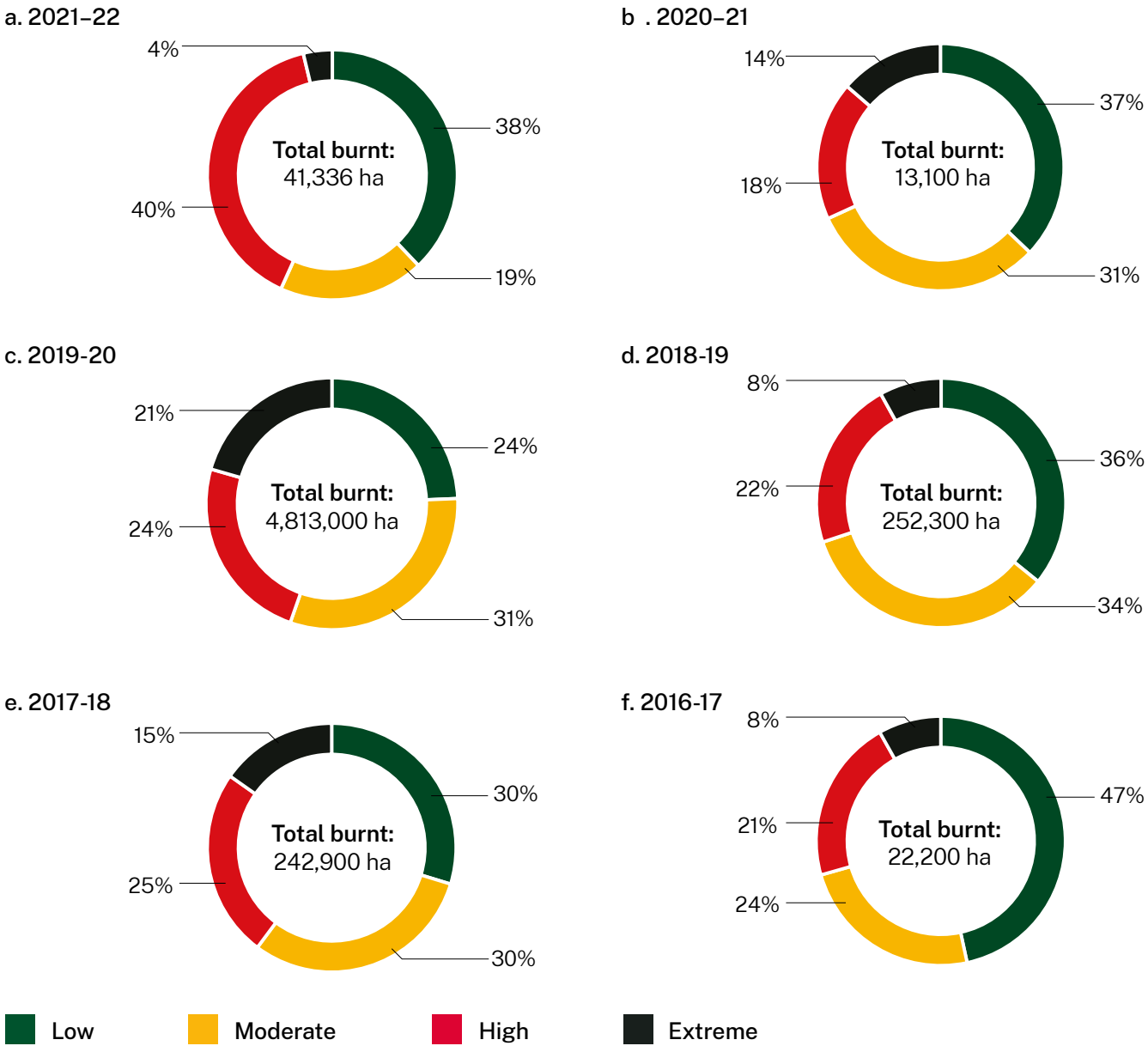


Figure 11 Comparison of the proportion of each severity class in New South Wales in (a) 2021–22, (b) 2020–21, (c) 2019–20, (d) 2018–19, (e) 2017–18 and (f) 2016–17 fire years

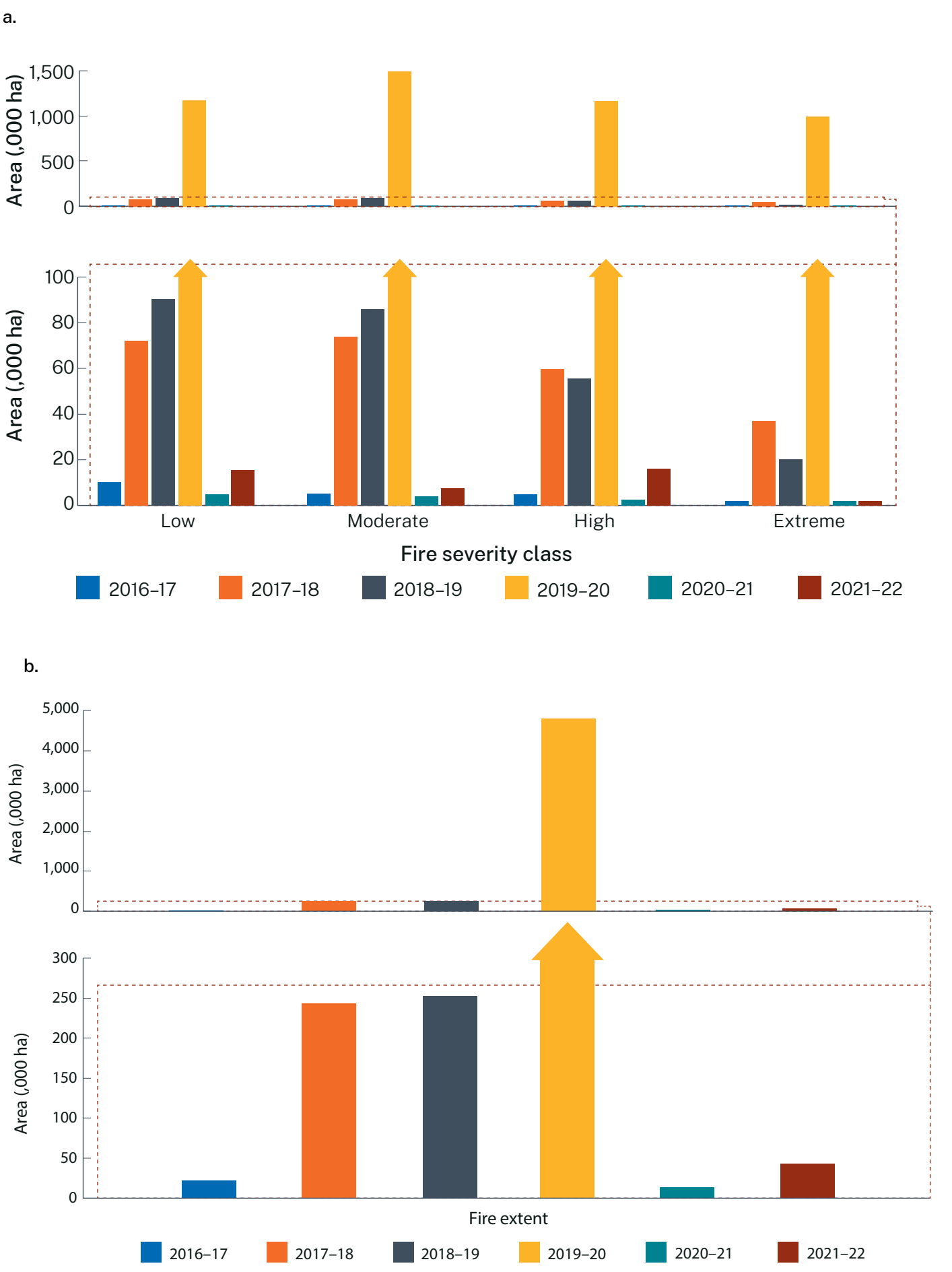


Figure 12 Comparison of (a) NSW fire severity, and (b) fire extent between the 6 fire years from 2016–17 to 2021–22. Note the 2 panels of each figure are on different scales, with the lower panel excluding 2019–20 data above 100,000 and 300,000 ha for (a) and (b) respectively

More information

Webpages and fact sheets

Bushfire Risk Management Research Hub

Landcover monitoring and reporting webpage, NSW Department of Planning and Environment.

Fire extent and severity maps webpage, NSW Department of Planning and Environment.

Recovering from the 2019–20 fires webpage, NSW Department of Planning and Environment.

Understanding the effects of the 2019–20 fires, NSW Department of Planning and Environment.

DPIE (2021) fact sheet: **'Supporting fire management with the fire extent and severity maps: fire mapping by machine learning',** 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 2021–22 fire year (XLSX 290KB)

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