Fires in the GunaiKurnai Landscape: Characteristics, Cultural Practices and Impacts on Cultural Heritage Places and Artefacts

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Executive Summary

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1. Introduction

November 2019 was a particularly hot and dry month across many parts of southern Australia. Over a four-day period, 18–21 November, temperatures reached record highs. On 21 November, 150 bushfires covering 326,000 hectares were recorded across Victoria; 60 of these fires were still burning by the end of the day, three of the largest in East Gippsland. The Bruthen and Gelantipy fires in particular continued to grow over the coming days.

A month later, on 20 December, a new heatwave led to 110 additional bushfires, again prominently in East Gippsland, with an area of 15,000 km^2 being particularly at risk. By 30 December, a host of new fires had burst through. "Three fires in **East Gippsland** with a combined area of more than 130,000 ha remained active; some fires burned with sufficient intensity to create pyrocumulonimbus clouds that generated local thunder and lightning" (https://knowledge.aidr.org.au/resources/black-summer-bushfires-vic-2019-20/). The fires continued to burn over the coming days and weeks, so that by 27 February 2020, as the fires waned, 1.5 million hectares of land had burned. The calamitous loss of approximately 120 lives through bushfire smoke inhalation, over 1000 cases of hospitalisation, and disastrous damage to property and resources had reached unprecedented levels (for a summary of impacts from the 2019–2020 Victorian bushfires, see https://knowledge.aidr.org.au/resources/black-summer-bushfires-vic-2019-20/).

While the 2019–2020 bushfires were particularly severe and widespread, GunaiKurnai Country has suffered a number of major bushfires over the past century. The Black Friday Fires of 1939 burnt 35% of GunaiKurnai Land and Waters Aboriginal Corporation (GKLaWAC) Country; the Gippsland Fires of 1965, 17%; the Great Divide Fires of 2007, 27%; the Gippsland Fires of 2019–2020, 20%. These individual fires (bushfires in rapid succession) all burnt huge areas of land. They had severe impacts at the time, and have had continued or cumulative effects on people's lives. But what has not yet been documented are the ongoing impacts the 2019–2020 together with the earlier bushfires, and the combined impacts of prolonged small bushfires and their frequency, location and extent have had on Aboriginal cultural sites in GunaiKurnai Country.

In light of these calamitous bushfires, and under the already-proven success of an established Memorandum of Understanding for partnership research between GKLaWAC and Monash University, a few months after the 2019–2020 bushfires GKLaWAC commissioned the authors (through the Monash Indigenous Studies Centre at Monash

University and the Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage) to undertake a desktop study of the distribution of registered cultural sites across the geographical spread of the 2019–2020 Gippsland and earlier bushfires in the GKLaWAC Registered Aboriginal Party (RAP) area. The study was to be undertaken in partnership with GKLaWAC as part of the Victorian government's Bushfire Biodiversity Response and Recovery (BBRER) program, and as a background step in community-led on-Country cultural heritage and biodiversity bushfire response and recovery. The study's major aims are to understand the impacts of landscape fires on cultural sites across GunaiKurnai Country.

This desktop review reports on these studies, and fulfils the four major aims to:

a) Review the literature for information on effects of fire on cultural sites in GKLaWAC Country.
b) Review and document GunaiKurnai burning practices.
c) Plan research projects to fill gaps in understanding the effects of bushfires on cultural sites.
d) Build on previous research by GKLaWAC to develop a high-quality report and publishable paper(s) on the topic.

2. The GunaiKurnai Land and Waters Aboriginal Corporation: People and Country

The study area covers the whole of the GKLaWAC RAP area, being the Registered Aboriginal Party that represents the GunaiKurnai Aboriginal Traditional Owners of eastern Victoria, southeastern Australia. Comprising some 25,770 km^2, the GKLaWAC RAP area extends from the mountains of the Great Dividing Range at Mount Hotham (1861 m above sea level) in the north to Bass Strait in the south (Figure 2.1). This is a diverse landscape, with only 125 km between the High Country and the coastal lakes. In pre-colonial times prior to the early 1800s, GunaiKurnai Country was partly insulated from neighbouring groups by mountain ranges to the north, the sea to the south, and dense temperate wet forests to the east. Many traditions and cultural practices differed from those of outside groups, who were referred to by GunaiKurnai as *brajerak*, “aliens” or not-GunaiKurnai (Howitt 1904: 41).

Figure 2.1. Location of GunaiKurnai Country, showing location of archaeological sites in and near GunaiKurnai Country where major findings have been made through archaeological excavation (by CartoGIS Services, College of Asia and the Pacific at the Australian National University, using Esri ArcMap 10.5 (https://desktop.arcgis.com/en/arcmap/) and Adobe Illustrator CC 2017 (21.0) https://helpx.adobe.com/au/illustrator/release-note/illustrator-cc-2017-21-0-release-notes.html).

The GunaiKurnai were traditionally divided into five dialect groups or “clans”: the Brayakaulung, Brataualung, and Tatungalung to the west; Brabralung in the central area; and Krauatungalung to the east, with smaller, fluid residential groups (sometimes called "bands" in the literature) within each of these larger groups (Fison and Howitt 1880: sketch map; Howitt 1904: 73) (Figure 2.2). The five main clans each have Country that includes parts of the coast or the large lakes system, but only Brayakaulung, Brabralung and the Krauatungalung have mountain areas in their territories. The rugged nature of the High Country to the north meant that there were only a few travel routes through the mountains (Howitt in Smyth 1878, vol. II: 325). In Krauatungalung Country, where archaeological research has been focused over the past four years and where the 2019–2020 bushfires were particularly severe, the Snowy River (Doorack) was a major travel route between the coast and the mountains (Bulmer in Smyth 1878, vol. II: 191; Howitt 1904: 518, 693).

Figure 2.2. "Sketch map of Gippsland, showing approximately the positions of the clans of the Kurnai tribe" (from Fison and Howitt 1880: 8).

Understanding GunaiKurnai social relationships is key to understanding the archaeological sites and artefacts in the landscape, because people and goods travelled at least as much to maintain social connections and affiliations with different parts of Country as for food and other material resources. The activities, contents and locations of camps and other frequented places, now evident as archaeological and oral history sites and artefacts, were a product of those connections and patterns of mobility.

Contact with outside groups was more fluid on the outer edges of the five clan territories. Cross-cutting clan affiliations, the GunaiKurnai were divided into two ancestral eponymous "sex moieties" named after birds (totems), *yiirung* (Emu Wren, *Stipiturus* sp.) or "elder brother" for the males and *djiitgun* (Superb Warbler, *Malurus cyaneus*) or "elder sister" for females (Howitt 1904: 103, 148). Neither of these species could be injured, for to do so would be tantamount to injuring kin of that sex. "Fights between the sexes on account of the killing of the brother or sister totem" were widespread (Howitt 1904: 148–149; Pepper 1980: 37). This highlights one among many ways in which GunaiKurnai Country and all within it is socialised, so that fire damage to the landscape is also damage to GunaiKurnai society and culture: the animals, and the plants, are more than zoology and botany; they are part of the GunaiKurnai social world. Traditionally GunaiKurnai daughters took their mother's sex moiety and sons took their father's, with marriage taking place outside (i.e., exogamous) to one's local residential group (which consisted largely of close kin) and undertaken by arrangement, elopement or capture. *Yiirung* therefore married *djiitgun* or outsiders (*brajerak*), and residence was predominantly patrilocal (Fison and Howitt 1880: 199, 204, 227). GunaiKurnai men thus married GunaiKurnai women of the opposite sex moiety, including across clans and with *brajerak* especially from the east. GunaiKurnai men thus lived in their father's Country and women lived in their husband's country, and men could, if marrying *brajerak* women, access their wives' Country to the east and to the north (Fison and Howitt 1880: 204). Accordingly, people also travelled across the landscape through such associations, connecting to different parts of the landscape through their kinship affiliations and relationships, spreading material goods and cultural practices along the way, and creating and maintaining travel routes and archaeological sites in the process. Different parts of GunaiKurnai Country were thus culturally inter-connected in various ways, and individual events in one area could affect GunaiKurnai or other Aboriginal groups further away, including where to burn the landscape to maintain "healthy Country" according to ancestral and kinship affiliations and managerial rights. While some of the old ways are not now followed, others are, including relationships to clan lands and managerial roles that these entail.

3. GKLaWAC Healthy Country, Whole-of-Country Plan

GKLaWAC has developed a Whole-of-Country Plan, towards the nurturing and maintenance of healthy Country that incorporates GunaiKurnai knowledge and educational opportunities for community members. Fire and its management is an important dimension of keeping Country healthy.

It is important to understand what the notion of "Country" means in GunaiKurnai culture. Country includes the land, waters and sky and all the living and inanimate things such as the rocks and soils within it all as one. But it is also more than this: Country includes the ancestral presences, their past actions, the present peoples, and the relationships between them and with all the things that reside or pass through the GunaiKurnai landscape. GunaiKurnai management of Country includes the cultural ways of keeping the landscape healthy, as passed down from the Old Ancestors; together with new ways that are embraced by GunaiKurnai Traditional Owners. GunaiKurnai Traditional Owners "are guided by the spirits of our ancestors when we walk through this Country. … We have a cultural responsibility to ensure that all of it is looked after. … Our spiritual connection is something that cannot be seen, but nevertheless exists strongly in the places we walk and in the paths of our ancestors" (https://gunaikurnai.org/wp-content/uploads/2021/07/Gunaikurnai-Whole-of-Country-Plan-ONLINE.pdf).

The GKLaWAC Whole-of-Country Plan has direct relevance to the management of Country and bushfires:

> [It} has drawn heavily from the aspirations that our mob have expressed over many years. We have worked hard to be faithful to all of the work that was done before, and bring it into the new context in which we are now operating. We are now embarking on a fresh push to implement the things that our mob has cared about for a long time. (https://gunaikurnai.org/wp-content/uploads/2021/07/Gunaikurnai-Whole-of-Country-Plan-ONLINE.pdf).

The Plan is based on nine fundamental Principles:

> **We have cultural obligations**. It is our inherent responsibility to look after Country—to heal the damage of the past and protect it for future generations.
>
> **Everything is connected**. All of our Country is linked. There is no separation between our landscapes, waterways, coasts and oceans, and natural and cultural resources. All are linked and bound to our people, law and custom.

Every bit matters. We understand the need to prioritise limited resources to where important values are under threat, but every part of our Country remains important to us.

Our values exist even when you can't see them—whether they are under water, deep inside caves, covered with vegetation, they are still important to us.

Don't wait until it has gone. When you lose a site, it's gone forever. We need to act now to prevent any further loss of environmental or cultural values.

Look at what was there before. When we are healing and restoring degraded landscapes, we should try to put back the plants and animals that used to be there.

Sustainable use. Our approach to managing Country is to balance resource use with conservation—they are all part of the same. Take only what you need—leave some for others.

Seek collective benefits. We use our resources for the benefit of our mob rather than seek individual gain.

We have the right to be on our Country. Traditional Owners should not be restricted in accessing our traditional Country. At the same time, we should have the right to restrict access to others who disrespect and damage our sensitive areas.

Our traditional knowledge is valuable. Our traditional practices and approaches sustained the land for thousands of years. Our Country should be managed in harmony with our traditional ways. We need to take the time to understand what natural and cultural heritage exists out on Country. It can't be managed properly if we don't know what is there. (https://gunaikurnai.org/wp-content/uploads/2021/07/Gunaikurnai-Whole-of-Country-Plan-ONLINE.pdf).

In this context, it is important to note that GunaiKurnai cultural heritage sites—archaeological sites and story places from the old days—are non-renewable ancestral places. They are GunaiKurnai "history books" written in the landscape. Through time, as more and more sites get damaged or destroyed through disasters such as bushfires and the expanding footprint of developments such as roadworks, urban growth and the like, progressively less sites survive; GunaiKurnai cultural heritage sites are a diminishing "resource". It is thus especially incumbent on land managers to carefully treat cultural sites, and in the event of widespread calamities such as bushfires, to retain a sharp awareness of the special place of Aboriginal places during fire-management and fire-fighting planning to recovery.

After a bushfire, the GKLaWAC Bushfire Recovery Crew works across the fire's footprint area, monitoring the impacts of bushfire on cultural heritage sites and the broader landscape, towards the management of the fire's impacts such as the recovery of species that are significant to the community. Such management practices are also a means of cultural learning on Country. As GKLaWAC points out:

> Country heals us and connects us to our ancestors, our culture and our history. But our mob cannot be healthy when Country is sick which is why it's been so important to get community out and involved in bushfire recovery—reading and healing, connecting and sharing knowledge. (https://gunaikurnai.org/our-country/bushfire-recovery/).

4. GKLaWAC and the Victorian Traditional Owner Cultural Fire Strategy

Articulating with the GKLaWAC Whole-of-Country Plan towards healthy Country is the *Victorian Traditional Owner Cultural Fire Strategy*. Its purpose is to "reinvigorate cultural fire through Traditional Owner led practices across all types of Country and land tenure; enabling Traditional Owners to heal Country and fulfil their rights and obligations to care for Country". Cultural fire refers to the knowledge and practices of burning parts of Country towards its short-term to long-term management. Cultural burning is done at particular times of the year, under appropriate conditions, by the appropriate Traditional Owners for that land, and using fire technologies that are appropriate for the job at hand. "Cultural burns are used for cultural purposes—they are not simply about asset protection. Cultural burns protect sites and clear access through Country for cultural uses—hunting, access to fish traps, ceremony etc.". (https://gunaikurnai.org/wp-content/uploads/2021/07/Victorian-Traditional-Owner-Cultural-Fire-Strategy-ONLINE.pdf).

With these aims in mind, the *Victorian Traditional Owner Cultural Fire Strategy* is based on six Principles:

Principle 1. Cultural burning is right fire, right time, right way and for the right (cultural) reasons according to Lore. There are different kinds of cultural fire practices guided by Lore applicable across Victoria's Countries.

Principle 2. Burning is a cultural responsibility. Traditional Owners lead the development and application of fire practice on Country; the responsibilities and authority of Traditional Owners are recognised and respected.

Principle 3. Cultural fire is living knowledge. Aboriginal fire knowledge is shared for continual learning and adaptive management. Traditional Owners will work together on each other's Country to heal Country and guide practice development. Knowledge and practice are shared.

Principle 4. Monitoring, evaluation and research (MER) support cultural objectives and enable adaptive learning. MER will be used to build a body of evidence that allows cultural burning to occur and grow.

Principle 5. Country is managed holistically. Traditional Owners manage Country holistically to address multiple values and objectives, healing both Country and culture. Partnership arrangements and management objectives are tailored to each regional and cultural landscape context. This includes analysis of the tenure, regulatory and operational arrangements to support cultural fire application, other beneficial Indigenous management practices, together with a process of learning to continuously improve planning, management and action.

Principle 6. Cultural fire is healing. There are substantial positive impacts to Traditional Owner wellbeing and confidence through providing access and authority to practice on Country.

GunaiKurnai cultural burning is about caring for Country, and helps restrict and manage a landscape that is less at risk of uncontrolled bushfires—wildfires—for example by burning dry undergrowth and leaf litter that can act as kindling in Gippsland's hot summers, or burning in relatively small areas or "patches" so that different parts of the landscape retain differential patches of growth. Cultural fire is a tool for managing Country (https://gunaikurnai.org/wp-content/uploads/2021/07/Victorian-Traditional-Owner-Cultural-Fire-Strategy-ONLINE.pdf). Accordingly, the *Victorian Traditional Owner Cultural Fire Strategy*, embraced by GKLaWAC, has four major Objectives:

a) For Traditional Owners to develop and lead on-Country cultural burning pathways.
b) To build Traditional Owner governance and capacity in cultural fire knowledge and practice.
c) To improve landscape management through collaborative practice, to heal Country, and build community and landscape resilience.
d) To develop and strengthen institutional frameworks that support cultural burning practices.

While in the present report we are concerned mainly with **bushfires**, each section of the report is aligned both with the *Victorian Traditional Owner Cultural Fire Strategy*'s four Objectives, and with GKLaWAC's aspirations to build respectfully shared knowledge and research that can add positively to the GunaiKurnai management of GunaiKurnai Country (including to reduce current and future negative impacts of bushfires), as expressed in the Whole-of-Country Plan.

5. Bushfires

By Grant Williamson and Jessie Buettel

Australia is a continent shaped over many millennia by fire. The flora and fauna, from tropical savannas, to the arid interior, to the wet forests of southeastern Australia, have lived and evolved under fire, and many have traits that let them tolerate and thrive under this disturbance. People have also lived alongside landscape fire, and used it as a tool throughout this long history. However, not all fires are created equal; cool burns in the cooler months have very different behaviour and impact on Country than the intense, difficult-to-control bushfires that dominate the summer months.

Many ecosystems in Australia rely on fire, even intense bushfires, to function and remain healthy. Fires release nutrients into the soil through the ash they produce, promoting new plant growth, and trigger germination in many species. Some systems, like wet forests, only burn very rarely under the most extreme conditions in high intensity fires, but this disturbance is required to allow establishment of the next generation of trees. However, bushfires that are too intense, or too frequent, for a given ecosystem, can disrupt these processes of regeneration and result in a loss of species and a shift to a new ecosystem type. Conversely, a long-term lack of fire in some systems can reduce biodiversity, as plants that require fire for regeneration die out and animals that rely on them for food and shelter leave the system.

An important characteristic of a bushfire, compared to a prescribed or cool burn, is the **intensity** of the fire. Intensity refers to the energy released by the fire, the amount of heat it produces as it consumes the fuel, and this is often closely related to the height of the flames. Bushfires are more intense than cool burns, producing greater heat (which can damage structures and cause greater risk to people) and higher flames. Intensity describes the *energy* released by the fire, and is often measured and expressed in units of kW m^{-1} radiating from the fire-line. This fire intensity, which translates to flame length and temperature experienced in front of the fire, varies with fuel type and weather (Table 1). There is also a relationship between the intensity of the fire and its **severity**. Unlike intensity, which refers to the heat and energy of the fire-line, severity is an ecological measure that describes impact of the fire on the environment. Severity illustrates another difference between bushfires and cool burns; bushfires tend to have higher severity, consuming more of the available fuel and producing flame heights that can damage or remove higher layers of the forest canopy, while cool burns have a lower severity, impacting only layers of vegetation close to the ground, and often in a patchy pattern.

Tabe 5.1. Fire-line intensity and fire regime intervals for common vegetation types of temperate southeastern Australia (after Murphy et al. 2013).

		Intensity ($kW\ m^{-1}$)		
Vegetation	**Surface Fuel Type**	**Typical**	**Extreme**	**Typical Interval (years)**
Tall/Wet Eucalypt Forest	Sclerophyll Litter	5000–10,000	>50,000	20–100
Dry Eucalypt Forest	Sclerophyll Litter	1000–5000	10,000–50,000	5–20
Eucalypt Woodland	Tussock Grass	100–1000	1000–5000	5–20
Temperate Rainforest	Rainforest Litter	0–100	100–1000	>100
Heath	Sclerophyll Litter	1000–5000	10,000–50,000	20–100
Pasture/Cropland	Tussock Grass	100–1000	1000–5000	5–20
Mallee	Sclerophyll Litter	1000–5000	10,000–50,000	20–100

Rate of spread is the speed at which a fire front moves, and is driven by the fuel, the shape of the landscape and, importantly, weather conditions. Rate of spread is often greater in a bushfire and contributes to the difficulty of fire control and suppression. In Australian forests, under extreme weather conditions when flames reach the canopy, bushfires can spread very rapidly. Fuel, and the continuity or connectedness of that fuel across the landscape, also plays a role, with bushfires having been observed to slow down upon reaching areas that have undergone recent prescribed burns.

As well as these characteristics that define how a fire burns, we can also characterise bushfires in terms of their **fire regime**. One element of this is fire frequency or interval; how often has an area burnt throughout history, and what is typical for that vegetation type? This varies greatly across Australia, with tall, wet forests having a fire return interval on the scale of centuries, while savanna grasslands in northern Australia can burn almost every year. Another feature of bushfires, compared to cool burns, is their typical size. Due to the high intensity and rate of spread under hot, dry weather conditions, and the difficulty in controlling them, bushfires can burn extremely large areas over multiple days. Cool burns, on the other hand, tend to cover small areas in a patchy mosaic, and due to the cool, moist conditions overnight, usually extinguish themselves in the evening.

A range of factors drive the occurrence, behaviour, intensity, and ecological severity of bushfires (Figure 5.1). **Fuel** refers to the organic matter that burns in a fire; this can include surface fuels like bark, leaves and dried grass on the ground, through to live shrubs and bushes, heavier logs, and the forest canopy itself under extreme conditions. The types of fuel present in different vegetation drives fire behaviour, such that bushfires in open grassland have different intensities and fire regimes than those in dense, closed forests. Fuel is produced by the vegetation present, so while a fire consumes fuel, it will build back up over time after the fire. The rate at which this occurs is different in different environments; grassy systems will regrow the grass rapidly in the next growing season, while dropped bark, twigs, branches and leaves build up more slowly over many years in southeast Australian forests but can reach much higher loads. The primary tool we possess to alter the intensity of bushfires is through managing the fuel load, the mass of fuel that is available to burn in a fire. Cool or prescribed burns consume some of that fuel under moderate weather conditions, so there is less available to drive bushfires under hot, dry conditions.

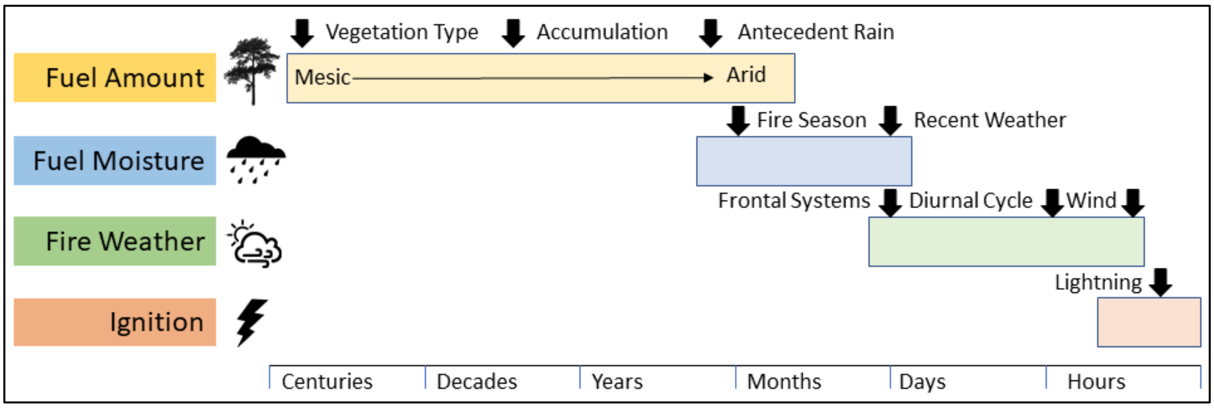


Figure 5.1. We can view fire occurrence as driven by four switches, that all need to be turned “on” for a fire to occur: fuel needs to be present; it needs to be dry; there needs to be appropriate weather conditions for fire to spread; and there needs to be a source of ignition, natural or human. These various “switches” operate over different time scales; fuel may take decades to build up in a system, whereas ignition is instantaneous.

In the short term, once a fire has started, weather conditions are a major driver of fire behaviour, and people have little control over them (although human-driven climate change, where it produces hotter and drier conditions, is expected to increase fire risk). A useful summary of the weather elements that drive fire can be found in the measurements used to calculate the Forest Fire Danger ratings which are commonly reported in daily weather forecasts over the summer. Wind speed, temperature, relative humidity, and a drought factor that describes the amount of moisture in fuels are combined to determine the fire danger, which in turn gives an indication of expected rate of spread, intensity, and flame height (Figure 5.2).

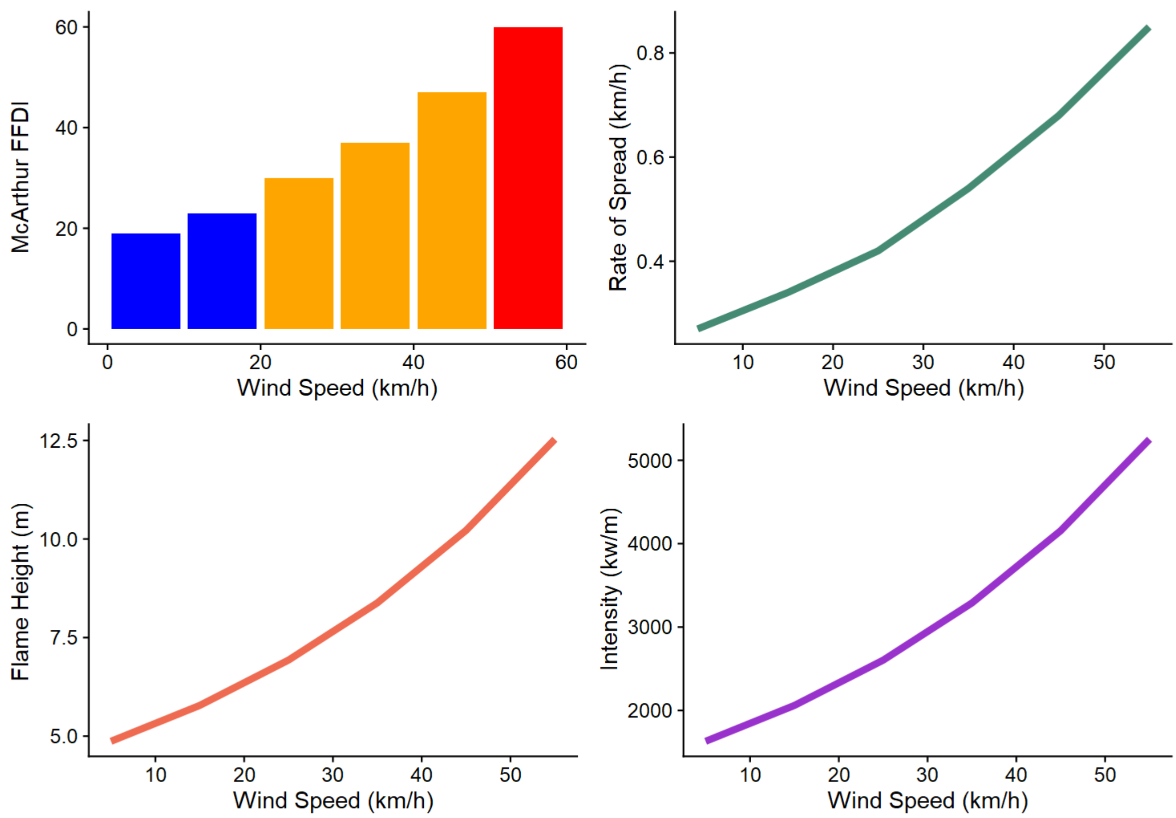


Figure 5.2. Influence of a weather variable (wind speed) on fire behaviour. Graphs are plotted for a forest under moderate drought (Drought Factor of 8), 30 °C temperature, 15% relative humidity, and a fuel load of 12 tonnes/hectare, typical for southeastern Australian dry forests in summer.

The amount of moisture in the fuel is related to recent weather conditions, with precipitation introducing moisture into the fuel, and evaporation on warm, dry days drying it out. However, different types or sizes of fuels respond to external moisture on different time scales. Very fine fuel components, like leaves and twigs, will become saturated easily when it rains, but then dry out rapidly when the weather is warm; but larger bulky fuels, like fallen logs, may take months to dry out after rain to become flammable, and may remain dry enough to burn after moderate amounts of rainfall occurs. Dry fuels, high fuel loads, high temperatures and low humidity all increase the amount of fuel available to burn, the rate at which it burns and the energy released, and high wind speed can increase the rate of spread and ensure the fire is fed with oxygen. In southern Australia, extreme fire danger days are often characterised by strong, hot, north or northwesterly winds carrying dry air from the interior of the continent. Often these conditions are followed by a cool change that brings a sudden shift in wind direction, spreading fires out suddenly in new directions. Under these conditions, bushfires can be difficult to impossible to control.

The landscape and terrain also drive bushfire behaviour. Fire tends to travel uphill faster and with a greater intensity than when travelling downhill, as flames are better able to reach unburnt fuel ahead of the fire when it is upslope of the front. North-facing slopes tend to be drier and warmer due to their greater exposure to the sun, which drives both different vegetation and more intense fire behaviour, than on moister south-facing slopes. Sheltered valleys with watercourses and wet, riverine vegetation often make natural barriers to bushfire spread, although under severe drought conditions, as were experienced in the 2019–2020 Gippsland fires (sometimes referred to as the 'Black Summer' fires), even these areas may be flammable and stop acting as barriers.

For fire-fighting personnel on the ground, the height of the flames provides a good indicator of the heat they will be facing, as it is strongly related to the intensity or energy of the fire. Research has shown that firefighters in protective clothing may be able to tolerate a radiant heat of 7 kW m^{-2}, which for high-intensity bushfire in extreme weather conditions, with flames approaching 25 m in height, a safe distance of 100 m from the flames can be maintained at a minimum (Figure 5.3). For cool burns under mild weather conditions, where flame heights are low and less fuel is available to burn, the safe distance is much shorter.

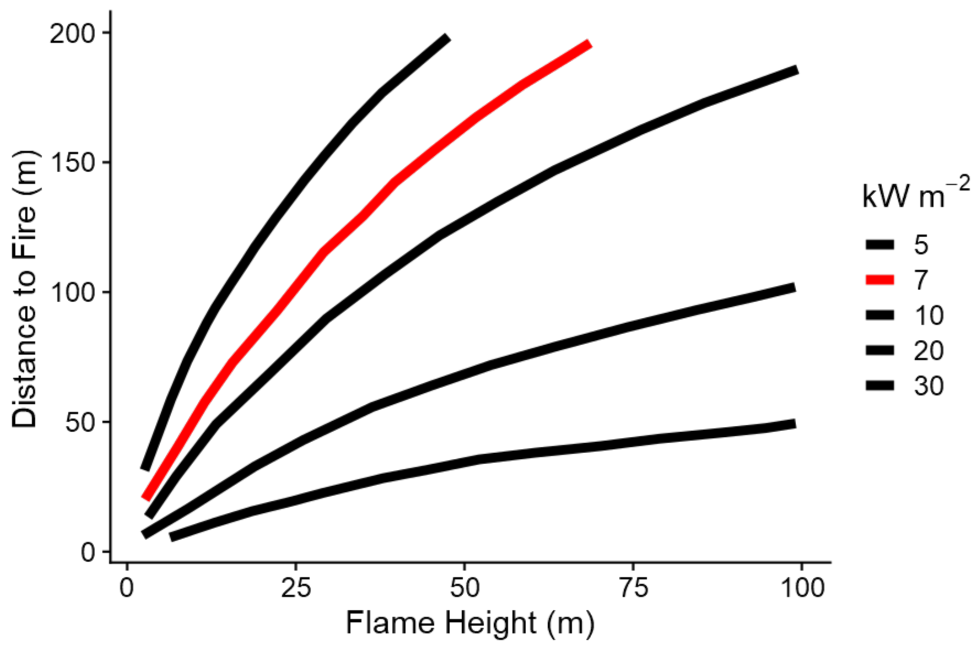


Figure 5.3. Relationship between flame height, distance from the fire-line, and heat intensity (after Butler and Cohen 1998). The red line shows the limit to prevent injury while wearing firefighting apparel.

Bushfires impact human settlements and infrastructure, given their high intensities and difficulty of control, and land use changes that are seeing more people living on the urban fringe and on properties enveloped by fire-prone forests, are shifting the profile of fire risk across the country. Other land use changes, such as the conversion of rarely-flammable wet forests to younger, more open plantations of different species, can also change the fire regime and the risk of fire.

One of the important secondary effects of severe bushfires, beyond immediate impacts on the flora and fauna, are changes to the land surface through erosion (the transport of soil and rocks) and denudation (the overall lowering of the land surface). The consumption, by the fire, of surface leaf litter leaves the soil surface exposed, while the death of live shrubs results in a loss of roots holding the soil together. This effect is particularly pronounced when fires are followed, in subsequent months, by significant rainfall events, before the vegetation can recover. The immediate erosion risk causes impact particularly in drinking water catchments, with the potential for soil and ash from the fire to wash into rivers, lakes and reservoirs.

Severe bushfires have three main impacts on the preservation and maintenance of cultural artefacts and layers in an archaeological site, the first through the direct impact of heat from the fire on the material, the second through the erosion and denudation processes detailed above, and the third as the result of human responses to the fire.

Soil is, generally, an excellent insulator for heat. While above-ground flame temperatures in the burning fuel and vegetation may range from over 1000 °C at the base of the flame to 200–300 °C at the tip of the flame, only a few centimetres under the soil temperatures may be quite survivable for many organisms. Through these insulating properties, a soil seed bank that enables vegetation reestablishment is able to survive. However, despite temperatures being significantly lower underground than above ground, the temperatures are still elevated and can have an impact on artefacts and materials. The degree of impact depends on the depth at which the materials lie, with heat at the surface being much greater than at depth (Table 5.1). Penetration of heat into the soil is driven to some extent by the intensity of the fire itself, based on weather conditions and fuel, although this effect appears less important than the effect of the residence time of the fire—how long it continues to burn at a given location before fuel is consumed and the fire is extinguished. Fires in light, grassy fuels tend to move rapidly, burn out the fuel at a given location quickly, and have a lower temperature than fires burning through coarse woody debris, where heavy logs may remain burning for hours after the main fire-front has passed, significantly heating the soil underneath. Moist soil, which is more likely to be present during cool-season burning, may also act as a better thermal insulator than extremely dry soil.

Many studies of below-ground temperatures from fire are based on data collected in the United States and Canada. However, these data are of little relevance to Australia. Fire-prone North American ecosystems tend to be dominated by conifers (pines) which leave a thick layer of *duff* consisting of decaying pine needles and related organic matter (Figure 5.4). This layer can continue to burn hot for a long time after the main fire-front has passed, and is close to the soil surface, so its attributes have to be considered when determining underground heating. Australian ecosystems often lack this dense organic duff layer, with the surface fuel being dominated instead by more aerated eucalyptus leaves and bark, which burn and extinguish more rapidly. It would be beneficial for more data on soil temperatures under varying vegetation types, fuel loads and fire conditions to be collected in southeastern Australia, including in GKLaWAC country. This can be accomplished by installing thermocouples at defined depths under the soil surface (0 cm, 2.5 cm, 5 cm and 10 cm) prior to prescribed or cool burning and recording temperatures as the fire front passes. A limitation to this methodology, however, is the difficulty in measuring more extreme bushfires, as their timing is unknown before they happen, rushing to install equipment ahead of the fire-front is dangerous, and there is difficulty in maintaining the recording equipment in the extreme temperatures of the fire-front. An alternative approach is to install aluminium tags below the surface marked with temperature-sensitive paints (Rebbeck et al. 2006). A variety of paints that change appearance at different set temperatures are available, which can help determine maximum temperatures reached as the fire passes.

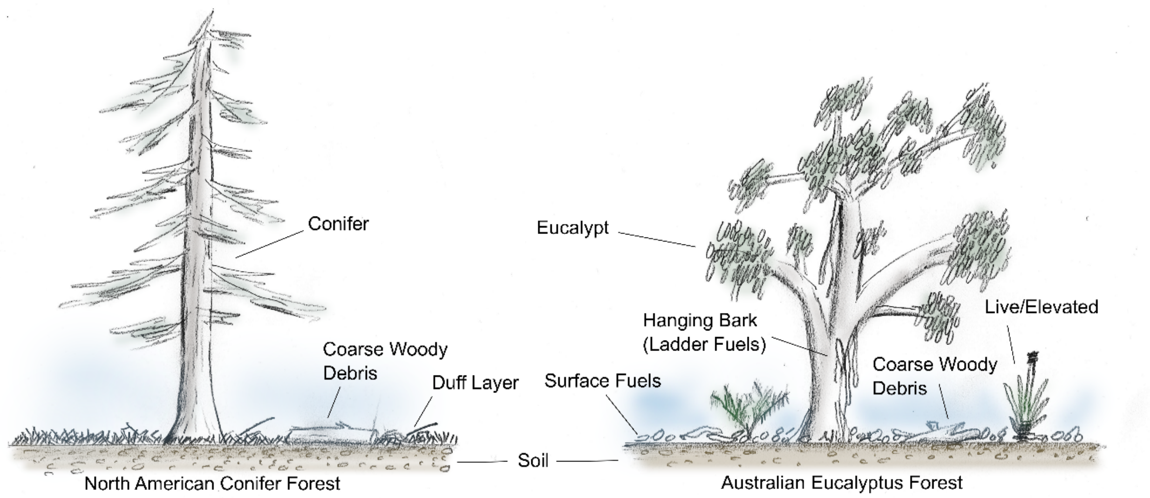


Figure 5.4. Comparison of North American fuel structure (left) and Australian eucalypt forest structure. North American forests, being dominated by conifers, have a dense duff layer, while eucalypt forests have a surface layer dominated by bark and leaves. Hanging strands of bark in some *Eucalyptus* species can help transfer fire to the canopy.

The actual direct impacts of the heat on surface or buried artefacts and archaeological layers depends on the physical material and properties of the artefacts and layers. In the case of wooden artefacts or those made from other flammable biological materials, complete consumption or scorching by the fire is possible, particularly where the items are close to the surface, while for artefacts of stone, shell or bone, the passage of fire can result in cracking, sooting or oxidation of the material.

Table 5.2. Field and experimental measurements of soil temperature at various depths. Temperature declines sharply with depth over just a few centimetres, and even severe fire differs little from prescribed fire at 5 cm depth.

	Depth					
	In litter	**0 cm**	**1 cm**	**2 cm**	**3 cm**	**5 cm**
1) **Prescribed fire (*E. pauciflora* forest) ACT** (Raison et al. 1986)	600 °C	450 °C		54 °C		42 °C
2) **Moderate fire, Blue Mountains NSW** (Bradstock & Auld 1995)		150 °C		50 °C		36 °C
3) **Experimental 25 kW m^2** (Enninful & Torvi 2008)			141.8 °C		50.6 °C	35.5 °C
4) **Experimental 75 kW m^2** (Enninful & Torvi 2008)			449.6 °C	102.2 °C	53.0 °C	

Erosion and denudation after the fire has passed, often associated with significant rainfall events, may uncover and expose previously buried artefacts and layers of sites, leaving them vulnerable to increased degradation by the elements or future fires, or possibly to looting. Disturbance of the soil from fire-killed trees falling may shift or bury materials. Artefacts may also be transported through the erosional processes away from their original locations, most likely down-slope or towards water courses. In such cases, stratified ancestral sites with great archaeological potential could be entirely destroyed through post-fire erosional events. This is particularly problematic because the ability of a site to tell the story of the ancestors largely depends on an ability to not be disturbed, to remain in situ, so that each layer tells its own story. Conversely, the erosional processes further up-slope may bury or increase the soil depth above material in down-slope or valley areas. Overall, the movement, exposure or burial of cultural materials through these processes may complicate stratigraphic understanding of a sediment sequence and history of artefacts following a fire. These are all, to a large extent, processes that are expected to occur in an exposed environment that bushfire, particularly severe bushfire, will accelerate.

The final factor impacting the state of artefacts during and after a bushfire is the human one. Actively fought bushfires are zones of high human activity, both on foot and by vehicle, where the immediate priority is protecting lives and assets, biased towards buildings and infrastructure, rather than surface and buried GunaiKurnai cultural materials that may be less easy to see. During firefighting operations, areas can become trampled, and earthworks may shift significant quantities of soil, shifting the location and depth of materials on the surface or underneath the soil. This disturbance may continue after the fire-front has passed during “blacking out” operations where fire agencies identify and extinguish smouldering logs and debris. Finally, as highlighted above, the loss of vegetation cover and exposure of shallowly buried material may enable interference and theft by people visiting the burnt area.

Simply as a function of the lower intensity of prescribed fire, with less heat penetrating the soil, lower consumption of fuel (and particularly of coarse fuels) and less firefighting activity on the ground, prescribed or cool burns would be expected to have less impact on the preservation of artefacts, archaeological sites and their stratigraphies than more extreme summer fires. Changes in climate, particularly warmer temperatures in the traditional cool burning season (spring and autumn) have the potential to shorten the window available for prescribed burning, and a projected increase in extreme weather events, including heat waves and intense rainfall events, may pose increased risk for the preservation and retention of cultural materials impacted by fires.

6. Methods of Investigating Landscape Fire Histories from Sediment Deposits

By Michael-Shawn Fletcher, Vanessa Wong and Bruno David

Bushfires and controlled fires both have long histories across the Australian landscape. Precisely how those histories look—how often fires burnt, how intense they have been, how widespread they were, where they burnt and when, etc.—remains the subject of both speculation and study. For most of Australia's c. 65,000 years of Aboriginal occupation, those records are not written in any history book, but rather in the landscape itself. How, then, can we read that landscape burning history from individual sites and landscapes?

Geomorphologists and biogeographers employ a number of methods to investigate fire histories. Such methods involve studying how fires have affected sediments, either by adding fire-affected particles that then became buried with accumulating sediments on ancient soil surfaces, or that modified those ancient surfaces such as through chemical alterations to soil properties. Exploring archaeological or sediment core sequences for those fire histories has become a common, although not routine, practice in both archaeology and palaeo-biogeography. Here we list key methods currently in use, and that can help better understand landscape-scale fire histories across GunaiKurnai Country over tens of thousands of years.

6.1 Pollen analysis

Pollen from plants falls on the ground and gets buried by accumulating sediments both on land and in water bodies such as lakes. As plant communities change through fires (some plant species are promoted by fires, others that are more sensitive to fire stop growing after fires), the history of plant taxa in pollen cores/sequences can also reveal information about fire history, especially when studied together with burnt particles on pollen slides.

6.2 Charcoal analysis

…

6.3 H:C ratios

Atomic H:C ratios can be used to indicate the temperature at which organic materials were heated under pyrolysis (decomposition under high temperatures) to form biochar (carbon-rich materials caused by burning) (Xiao et al., 2016). Lower atomic H:C ratios of sediments suggest evidence of burning or deposition of ash or charcoal.

6.4 Magnetic susceptibility

Fire can alter the magnetic properties of soils, particularly where there is a high iron concentration. This can be measured with magnetic susceptibility, which generally increases in fire-affected soils (Blake et al., 2006). More intense fires can result in greater magnetic enhancement (Till et al., 2021). The magnetic signatures are the result of the formation of magnetic iron minerals which form following fires, including haematite, goethite, maghaemite and magnetite.

6.5 Black carbon/pyrogenic organic matter structure

When organic matter is burnt, the chemical structure is altered, forming "black carbon" which is resistant to decomposition and persists in sediments (Knicker, 2011). Changes to the chemical structure can be measured using different techniques including solid-state ^{13}C nuclear magnetic resonance (NMR) spectroscopy (Almendros et al., 2003), pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) or thermogravimetry (De la Rosa et al., 2008).

6.6 Pyrogenic polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are organic compounds which are formed when substances are burnt, including plant material. These are generally known as pollutants that form during incomplete combustion of fuels, garbage, food, and tobacco. They can also act as markers for historical fire, and can be formed and measured over a broader temperature range compared to charcoal (up to 900 °C) (Conedera et al., 2009; Denis et al., 2012).

7. Aboriginal Controlled ("Cool") Landscape Burning Practices in Gippsland: Review of the Literature

By Seumas Spark

The historical and anthropological records tell of Aboriginal burning practices in Gippsland, including those of the GunaiKurnai, but this information is rarely explicit, and not always what is desired: little of the information comes from members of Aboriginal communities themselves (the name "GunaiKurnai" is absent from most of the records on which this report is based; it is used here in its present form for uniformity and convenience). As the environmental historian Stephen J. Pyne notes of Gippsland in his history of fire in Australia, "there are few solid references to routine Aboriginal burning" (Pyne 1991: 212). The voices of those who have cared for and burned the land for thousands of years are mostly absent from the written historical record.

Nonetheless, there is value in this written record of Aboriginal burning practices in Gippsland, even in those observations now known to be misguided or wrong. A close reading can provide insights. In their *Report on the Physical Character and Resources of Gippsland*, published in 1874, Skene and Brough wrote: "Nature in these regions has not been interfered with by man; and yet there was something almost artificial in the aspect of the hollow around the Diamantina Springs. The richly foliaged shrubs seemed to have been set in their places in obedience to rules of art …". Skene's and Brough's description hints at their having missed something, though it is unlikely that either considered the possibility of a mosaic landscape created through the careful application of fire by the area's Aboriginal inhabitants (Skene and Brough Smyth 1874: 39).

This section reviews the literature and knowledge on Aboriginal burning practices in Gippsland. It focuses on nineteenth and twentieth century literature, broadly chronologically and beginning c. 1840 with the non-Aboriginal (colonial) settlement of Gippsland. The literary record shows that White settlers in Gippsland learned that fire played a pivotal role in taming and managing the land, a recognition that connected them, in one small way, to the Aboriginal peoples of Gippsland. In the absence of mechanised machinery, fire was the most effective tool for clearing land, and necessity dictated that newcomers to Gippsland wield it. But there the understanding usually ended, for most newcomers did not learn Aboriginal ways with fire: when, how and what to burn. In the hands of the first White settlers, fire was a fierce and unpredictable weapon rather than a delicate instrument applied to Country with care.

Here we discuss the central importance of the work of Alfred Howitt, scientist, explorer and author, and show how much his pioneering scholarship informs the written historical record. We discuss also the importance of recording oral histories, including with non-Aboriginal people, to add to what is known of Aboriginal burning practices. There is evidence that non-Aboriginal cattlemen and women in Gippsland and southern New South Wales have long followed the advice of Aboriginal friends and employees, burning when told to do so. Sometimes—usually when it was a matter of livelihood—White men and women knew to defer to Aboriginal knowledge. These (hi)stories are reflected in oral reminiscences, and sometimes in maps that show fire-managed paths and clearings, but rarely in the written record. Capturing these (hi)stories would add much to knowledge of Aboriginal burning practices in Gippsland, including in recent decades. Aboriginal burning in Gippsland has been practised continuously since White settlement in the 1840s, and sometimes for the purposes of non-Aboriginal people.

In preparing this section, a detailed search of newspapers was conducted via the Trove database. This unearthed useful results about Aboriginal burning practices, though fewer than expected. Mentions of GunaiKurnai burning in newspapers tend to be confined to book reviews—articles on Howitt's scholarship, for example.

Two key principles inform this section. The first is that the best way to increase knowledge of Aboriginal burning practices in Gippsland is to talk with Aboriginal people. That information could then enter the literary record, given necessary permissions. All that follows here is written with this principle in mind.

The second principle is that this section does not engage with the argument advanced by some commentators that the extent of Aboriginal burning practices in Gippsland before White settlement has been overstated or, even, fabricated. Often such ideas are motivated by politics rather than evidence. This section instead proceeds on the understanding that the GunaiKurnai and other Aboriginal groups fired the land regularly. Aboriginal and non-Aboriginal peoples of Gippsland know this, so too the vast majority of scholars—historians, archaeologists, anthropologists, ecologists, botanists and others. Indeed, this understanding is common to literature in the humanities, social sciences, and the pure sciences. For example, Gell, Stuart and Smith (1993) used scientific methods to show that Aboriginal people were burning country at Tea Tree Point in East Gippsland long before colonial contact.

This section begins by presenting information collated from a series of interviews conducted with GunaiKurnai individuals in early 2021. In these interviews, undertaken as part of a separate GunaiKurnai Land and Waters Aboriginal Corporation (GKLaWAC) project, interviewees were asked questions about their knowledge and use of fire. The respondents offered information on the basis that GKLaWAC would ask their permission before sharing it further.

7.1 The GunaiKurnai and fire

In January–February 2021, I undertook a number of interviews with both GunaiKurnai and non-GunaiKurnai Aboriginal residents in GunaiKurnai Country about Aboriginal landscape burning practices in Gippsland. Aunty Phyllis Andy was interviewed on 20 January and 24 February 2021; Cheryl Drayton on 21 January 2021; Terylene Hood on 25 February 2021; Uncle Russell Mullett on 11 and 25 February 2021; Cathy Thomas on 12 February 2021; and Aunty Glenys Watts on 12 February 2021. Aunty Phyllis has lived on GunaiKurnai Country all her life but is not a GunaiKurnai woman. Her mother was from Wotjobaluk Country near Dimboola in western Victoria. Aunty Phyllis is grateful to the GunaiKurnai for allowing her to live on their Country and share in its beauty.

When I asked GunaiKurnai individuals about the use of fire, most mentioned its vital role in keeping Country clean, healthy and safe. “Clean” was a word used by several respondents. Cathy Thomas noted that small, knee-high, mosaic burns, conducted mostly in the colder months when ground is damp, ensured both the health of Country and its continuation as a source of bush-tucker and supplies. Cool burns benefit animals, and stimulate plants used by the GunaiKurnai for food and activities such as basket weaving. In the words of Aunty Glenys Watts, burning is an environmental strategy designed to protect an ecosystem. Aunty Phyllis Andy echoed this when she said that one reason for burning is to safeguard the future.

Both Aunty Phyllis and Terylene Hood remember that fire around Lake Tyers was once frequent, and not that long ago. Terylene spoke of her grandfather burning bush on a daily basis in the Lake Tyers area, while Aunty Phyllis recalled her father and other men burning

Country at the Bluff in the 1950s and 1960s. Because this was men's work she watched from a distance, but Aunty Phyllis believes the men shared an inherent knowledge of what to do. She laments that such burning is far less widespread than it was. GunaiKurnai Country today is as dry as she can remember, a fact she attributes to the absence of the firestick: cool burns promote the growth of particular plants, keeping moisture in the ground. Speaking of the catastrophic fires in East Gippsland in the summer of 2019–2020, Aunty Phyllis said that she had "never been so scared". This wasn't Aboriginal fire, she told me, but the creation of those who ignore Aboriginal knowledge and choose not to burn. Western rules, noted Terylene, have greatly restricted GunaiKurnai management of Country.

The responses of those who were interviewed for this report certainly highlighted differences between Aboriginal and non-Aboriginal people in their understanding of fire and landscape. Uncle Russell Mullett and Cheryl Drayton mentioned that Country tells you when to burn, and that these signals from the land, rather than dates or arbitrary rules, should dictate when fires are set. Cheryl noted that in GunaiKurnai country there can be six seasons a year, a concept that undermines the widespread practice of setting burns according to the less nuanced non-Aboriginal calendar of four seasons. Russell Mullett and Cathy Thomas mentioned also the importance of recognising and learning from the signals given by Country *after* a burn, cool or hot. What burned? What didn't? Which plants re-emerged, and when? Country both delineates Aboriginal approaches to setting fires, and shapes responses in their aftermath.

In her interview, Cathy Thomas emphasised that every fire is different and, as such, there is always a lesson to learn. After thousands of years of burning the land, GunaiKurnai continue to add to their knowledge of fire. Education is a protection against complacency, and a spur to action. As Russell Mullett observed, nature puts out fires, not people. Many non-Aboriginal people are yet to realise this.

7.2 Discovering a fire-managed landscape

When the first non-Aboriginal, colonial settlers came to Gippsland, they saw a fire-managed landscape, though they didn't always recognise it as such. Angus McMillan, who was among the first White men to enter Gippsland, described "beautiful open forest" and "park-like land" on his exploratory travels in 1840 (cited in Watson 1984: 112–113; see also Bride 1898: 254-259; Fell 1978: 13–15). Paul Edmund de Strzelecki was more lyrical:

> The region eastward of the chain in the direction to Corner Inlet presents a totally different aspect. At the latitude 37°, or about the sources of the river Thomson, the spurs are less ramified, and of considerable height and length, shaping the intermediate ground into beautiful slopes and valleys, which ultimately resolve into a fine open plain, richly watered, clothed with luxurious grasses and fine timber, and offering charming sites for farms and country residences. Viewed from Mount Gisborne, Gipps Land resembles a semi-lunar amphitheatre walled from N.E. to S.W. by lofty and picturesque mountain scenery, and open towards the S.E., where it faces, with its sloping area the uninterrupted horizon of the sea. (de Strzelecki 1845: 63; see also de Strzelecki 1841).

Such views as described by Strzelecki caught the eye of others, too, who saw Gippsland as a potential paradise for graziers. The historian and author William Westgarth described "tracts of a beautiful open grassy country, resembling in some respects the rich and lightly timbered pastures of the western district" (Westgarth 1848: 28). In 1847, the surveyor Francis Peter MacCabe produced a "Gippsland Rivers" map, with annotations indicating areas of "luxuriant" grass, good "pasturage" and "open forest" (Figure 7.1). The map depicts clearly a fire-managed landscape, though MacCabe did not connect these park-like landscapes to Gippsland's Aboriginal inhabitants.

Figure 7.1. Francis MacCabe's 1847 map shows a fire-managed landscape. The map itself, and MacCabe's detailed annotations, make this clear (from Genoa River, GIPPS 54, Historical maps and plans, State Library of Victoria, Melbourne).

Nor was the link always apparent to those who had some appreciation of Aboriginal culture, such as the writer "Tanjil" (Dow 2004: 133). Writing in 1886 of the "settling" of Gippsland in the early 1840s, he described its grassy plains and open country, then added: "Gipps Land in 1842 possessed all the features of a country in a state of nature. The white man had hardly made his mark, the black man's mark as yet predominated, though it did not amount to much, the remains of camps, trees notched in the act of climbing in the native fashion, near the lakes" (Tanjil 1886: 17).

Allan McLean (1840–1911) and his family were among the first White settlers in Gippsland, moving there in the early 1840s. McLean, who would later serve as Premier of Victoria and as a federal government minister in the early days of the Australian Commonwealth, grew up at Glenaladale. In a 1905 *Gippsland Times* article entitled "Reminiscences of Early Gippsland", McLean remembered fire as a constant presence. In spring his family and other settlers lit fires to clear vegetation, and in summer they feared the destructive power of bushfires. He recalled Aboriginal uses of fire, but believed it was employed as a weapon rather than as a means for tending country: "the blacks often started fires in order to burn us out" (Anonymous 1905: 3; see also RHSV, MS 000384, Box 125/7, Reminiscences of Allan McLean). There is evidence that Aboriginal people used fire as a defence against White colonists (see Cahir 2018: 124–127).

Other White men and women did see the hand of people in the landscapes of Gippsland, and came to recognise that fire was the tool that Aboriginal people used to craft Country. The pastoralist William Brodribb travelled through Gippsland in 1841: "The natives had burnt all the grass at Gippsland late in the summer. Heavy rains must have fallen before we reached there, in the month of March (Autumn). The whole country was very green. It had here the appearance of young cornfields; the young grass was about six inches high, and in places very thick". It is tempting for modern readers to think that Brodribb was wrong about burning in summer, but this would be a contemporary conceit. GunaiKurnai Elder Russell Mullett has confirmed that Aboriginal burning took place year-round, with the firing of landscapes depending, as always, on Country and conditions. In 1841 White settlement of Gippsland had not yet wrought the changes to country that would, in time, create the conditions for the firestorms now characteristic of Australian summers (Brodribb 1976: 24).

When travelling into Gippsland in 1844, George Augustus Robinson, Chief Protector of Aborigines for the Port Phillip district, connected the proliferation of messy scrub with the recent absence of Aboriginal burning (Clark 1994: 14). Later, near the Albert River in South Gippsland, he saw country "that had been burned, which Robinson took to be evidence that natives had recently been in this country" (Clark 1994: 16). His travels in Gippsland and into the Monaro region of southern New South Wales helped him to connect Aboriginal burning practices with certain landscapes. Of the Monaro, Robinson wrote: "It was a fine clear day in July when I first saw the Maneroo [Monaro] Country. The immense Downs with their undulating grassy surface stretched out before me as far as the eye could scan, a Park of great magnitude and beauty studded with copses of Banksia, Casuarinæ, Mimosa, Shrubs, and small belts of Eucalyptus" (Robinson et al. 1941: 14; see also Joubert 1876: 20). Such country, Robinson recognised, was the product of Aboriginal knowledge and practice.

The Reverend John Bulmer ministered at Lake Tyers from 1862 until the early twentieth century. More so than most of his non-Aboriginal contemporaries, he was interested in GunaiKurnai culture and practice. He wrote:

> In hunting the kangaroo all the available men of the tribes went together. Each was armed with two or three spears, barbed with pieces of flint or in more

> modern times with broken glass and a *marriwan* for throwing them. They generally went in a very large circle, and gradually closed in, leaving a narrow opening for the kangaroos which were speared in passing. But in summer they set fire to a large tract of country and speared the animals as they were escaping from the fire. They also got many after the fire almost roasted enough for eating. (cited in Vanderwal 1994: 61)

Like Brodribb, Bulmer was a witness to the GunaiKurnai burning of Country in summer.

7.3 Using fire

The journalist Donald Macdonald's 1887 book *Gum Boughs and Wattle Bloom* includes a chapter on Gippsland, in which reference is made to Aboriginal uses of fire: "… for a fire-stick—the great native scavenger and disinfectant—was thrust amongst the thatch when the [Aboriginal] huts were abandoned. Indeed, there are traces of fire all along the slope that suggest a line from 'Bush Ballad'—'All fire-flushed when forest trees redden on slopes of the range'" (Macdonald 1887: 78). Though few observers were as explicit as Robinson, Bulmer and Macdonald, nineteenth century literature shows that many of Gippsland's White settlers and visitors shared an understanding that Aboriginal people had used fire widely and regularly to shape the landscape. This understanding was often only vaguely formed, but it was there, as the literary record proves. White settlers knew also that fire might be made to work for them, specifically in clearing the landscape of scrub and bush. Ironically, some of the scrub they saw was due to Aboriginal people having been prevented from caring for Country and deprived of the chance to burn.

What the settlers often did not know was how to control fire. Caleb Burchett, born in 1843, settled at Poowong in South Gippsland in the 1870s. In a manuscript written in the early twentieth century, he described clearing the land so that he could sow grass seed: "This growth we called scrub and the first work undertaken was to cut this down and let it lie till after Xmas time, and then burn. If all things were favourable and a good burn was secured then the picking up of the timber left was comparatively light work and the fortunate selector would be said to have a 'Good Burn'. It was my misfortune to have almost every time a 'Bad Burn'" (Burchett, no date a).

In 1956, E. E. Straw expanded on Burchett's burning method:

> By the middle of December this portion of the block was strewn with piles of hazel scrub and dry undergrowth which would be ready to burn off by the end of summer, or earlier if a spell of hot weather produced favourable conditions. In this case, however, a heat wave and a long dry period made it possible to start the fire by the end of January. The great mass of fallen timber and debris had now become so dry and inflammable it only required a spark to touch off a great blaze. This was an anxious time for the settler. A good burn cleared up the block and minimized the work afterwards. A bad burn might postpone production for twelve months. Caleb therefore waited for the right weather—a hot day with a good wind was desired to fan the fire into an inferno. He postponed the event till the middle of February. This particular morning gave promise of a good start. Word was sent to neighbours, who assembled about 1 p.m. to help their fellow settler. They dispersed to different points of the clearing. At a given signal each one started the fire. They then made a torch of bark in order to light along the boundary. Once the fire had encircled the burn nothing more could be done. Everyone settled down to watch the seething mass of smoke and flame. Its concentration and intensity consumed everything within this 30 acres in a few hours. (Straw 1956: 6)

The concept of “good” and “bad” burns, and the idea that infernos were necessary, prevailed elsewhere in Gippsland. In 1920, a man named A. W. Elms contributed a chapter entitled “A Fiery Summer” to a book on the non-Aboriginal settlement of South Gippsland. Scrub, he wrote, was burned “In the Summer, on the hottest day available, and, if possible, with a strong wind blowing, the fallen scrub is set on fire, and if the burn is a good one, the fire burns up all leaves and small timber, leaving only the large saplings to be picked up and burnt off” (Elms 1920: 307). He added: “Once started, there was no control over the fire, which might burn for weeks in trees and hollow logs, ready to spread afresh with wind or hot weather” (Elms 1920: 307; see also Wakefield 1970: 153).

The squatter Patrick Coady Buckley “Set fire to tea tree scrub” in late November 1868. The month had been “very dry”, and two days after setting his burn, Buckley noted in his journal that there were “Bush fires all around” (Buckley, 30 November 1868). These signs didn’t stop him burning. A month later, on 29 December, he again “set fire to scrub”, though conditions had only worsened since November (Buckley, 29 December 1868). No rain had fallen.

We have included these examples in our review of the historical literature to show that non-Aboriginal residents of Gippsland also fired the land, prompted probably by direct and passive knowledge of Aboriginal burning practices. In his book *Dark Emu*, Bruce Pascoe mentions Jinoor Jack, an Aboriginal man, who explained to a White man how to burn in East Gippsland. Jinoor Jack mentioned a five-year burning cycle (Pascoe 2021: 167). The White man was Robert Alexander. Pascoe's source for this statement is a history self-published by Alexander's descendants: Jinoor Jack's knowledge, imparted in the 1850s or 1860s, was passed down through the Alexander family (excerpts available at https://www.towambavalleyhistory.webhive.com.au/alexanderfamily.htm). How many of Gippsland's White settlers received burning advice is unclear, though some certainly did: the concept of the five-year burning cycle was known to White settlers at different times and places elsewhere in Gippsland (Tonkin and Landon 1999: 208).

But there were crucial differences. The aims of the White settlers who burned the land were often different from those of the GunaiKurnai, their methods far less skilled and safe, and the results sometimes catastrophic (see Watson 2016: 11). The disruption caused to Country by the arrival of White settlers in Gippsland either made possible, or at least greatly exacerbated, the 1851 and 1898 bushfires. The science that informed cool burns, as practised by the GunaiKurnai and other Aboriginal peoples in eastern Victoria and southern New South Wales, was not generally understood by White settlers (Watson 2016: 12–13, 75). But they had learned that fire could be an ally. In this regard if nothing else, Aboriginal burning knowledge, corrupted and misunderstood though it often was, can be glimpsed in such writings as those of Burchett, Elms and Buckley.

7.4 Alfred Howitt and his scholarship

Much of what has been written about Aboriginal burning practices in Gippsland derives from the work of Alfred Howitt (1830–1908), explorer, scientist and anthropologist. His seminal studies of GunaiKurnai culture and practice continue to inform scholarship today.

In 1890, Howitt gave a paper to the Royal Society of Victoria entitled "The eucalypts of Gippsland" (see also discussion of Howitt's paper in *Proceedings of the Royal Society of Victoria* 3, 1891, pp. 124–129; Wardlaw 1997). He explained how White settlement had disrupted Aboriginal burning practices, which, in the words of Bill Gammage, let "undergrowth fill open forest and grass revert to bush" (Gammage 2011: 322; see also Morgan 2013: 17). Gippsland, Howitt told his audience, was more heavily forested than it had been fifty years earlier when the first White settlers arrived (Howitt 1890: 109–113). To the Aboriginal peoples of Gippsland, Howitt observed, "we owe more than is generally surmised for having unintentionally prepared it [Country], by their annual burnings, for our occupation" (Howitt 1890: 111).

Howitt's paper had little to say on how the GunaiKurnai burned. Rather, it was significant for stating that they had; it recognised that the GunaiKurnai and their neighbours had used fire to create the landscape that so appealed to Angus McMillan, Strzelecki and the other "discoverers" of Gippsland. Among the White settlers of Gippsland were those who knew through observation or anecdote that the GunaiKurnai had fired the land, but this was different: here was a scientist explaining how pervasive and important those burning practices had been, and the enormous effects that flowed from interrupting them. Howitt understood that the GunaiKurnai had never been passive occupants of Country, as was often the conclusion of White settlers (Dow 2004: 67–68).

Howitt had been thinking about these themes for some time. In 1869 a story entitled "Ella's Dream of How the Trees of Nuntin Forest Died" appeared in the *Gippsland Times* (Anonymous 1869: 4). The author of the story was identified only as a "contributor". Carol Dow writes: "The Nuntin Forest was a belt of dead timber extending from the Lakes inland for about seventy miles. By 1869 the trees 'young and old' were dead and dry, and no one knew 'the cause of their destruction'. Eight-year-old Ella F., a squatter's daughter, fell asleep looking at the forest of dead trees in the moonlight. She dreamt of the trees and related her dreaming to her mother" (Dow 2004: 62). Ella's dream described how the poisoning of a group of Aboriginal people and the misery this wrought on the GunaiKurnai had led to the death of the forest. The story was radical in recognising the iniquities that White settlers had inflicted on the GunaiKurnai and their Country. Dow suggests that it may have been written by Howitt, who at the time was police magistrate in Bairnsdale (Dow 2004: 64). She notes that the writer understood the depth of the GunaiKurnai's connections to Country—the dream was used as a vehicle to make this point—and that "Howitt later described the tree decline in the Nuntin area and concluded that it resulted from changed fire regimes" (Dow 2004: 62, note 92).

Howitt’s work on Aboriginal burning practices in Gippsland and beyond was noticed in the press (e.g. Anonymous 1891), and by some members of the public. In 1914, E. H. Lees of Fairhaven, Mallacoota, wrote a letter to the editor of *The Australasian* newspaper (Lees 1914a). Edward Lees was a surveyor who worked widely with the Victorian government in East Gippsland. He had a keen interest in Aboriginal culture and Australian flora (e.g. Lees 1914b, 1915). In his letter Lees cited Howitt and his own observations to confirm Howitt’s position on GunaiKurnai burning practices and their interruption by White settlers. Lees (1914a: 8) added: ‘’Bush fires have long preceded settlement, and ages before the advent of the white man vast areas were burnt off by the aboriginal occupiers accidentally and intentionally when hunting game”. The “best friend to forest and settler”, Lees wrote, “is moderate firing!”.

It is thought that Lees, who died on 30 June 1921, lived in East Gippsland for much of his adult life. The Victorian Public Record Office in North Melbourne holds extensive records of his work as a surveyor. A selection of these primary documents was consulted for this report. While this sample did not include information about his interactions with GunaiKurnai Country and burning practices, other records might. Further research into Lees and his career would be worthwhile.

7.5 Forgetting the past

References to GunaiKurnai burning practices in the nineteenth century written record range from vague and largely ignorant mentions to the well-informed comments of Howitt. That this record is relatively rich owes something to nineteenth century settlers in Gippsland having need of fire. Whether or not they understood the science of GunaiKurnai burning, and it seems that most didn’t, they did know that fire could help them: it cleared land and produced green pick for stock.

This recognition is less evident in the twentieth century literary record, perhaps because some settlers saw less need for fire: fertile land had been cleared, farming technology had advanced, and life on the colonial frontier in Gippsland was ever less precarious. By the twentieth century there was also, very often, a greater distance between White settlers and GunaiKurnai. The first White settlers in Gippsland had a closer view of GunaiKurnai culture and practice than did their descendants. Many descendants might have inherited a fear of fire, but at the same time forgot what their forebears had learned, one way or another, from the GunaiKurnai: that fire is a useful and important tool.

Those beyond Gippsland also wrote less about the ways in which GunaiKurnai tended Country. In 1966, E. C. F. Bird, a geographer at the University of Melbourne, wrote of the Gippsland Lakes before White settlement: 'the region was occupied only by a sparse aboriginal population, whose activities left little mark on the landscape … The effects of a nomadic population of hunters and gatherers of food on the vegetation and fauna of this region cannot be determined, but they were undoubtedly trivial compared with the impact of settlers in the last 120 years, and for practical purposes the Gippsland Lakes may be regarded as 'unmodified by man' at the time of McMillan's discovery" (Bird 1966: 56).

As non-Aboriginal people began to better understand the significance and sophistication of Aboriginal care for Country, observers wrote of GunaiKurnai burning practices in increasingly nuanced ways (see Griffiths and Russell 2018). In 1969, the archaeologist Rhys Jones published his seminal article "Firestick farming" (Jones 1969: 224–228), and in 1972 the historian Keith Hancock wrote his pioneering book *Discovering Monaro*. Hancock showed how Aboriginal people had managed the land, and in an area not far from GunaiKurnai country. The book's sub-title was *A Study of Man's Impact on his Environment*.

Others took the understanding articulated by Jones and Hancock and applied it to Gippsland. In a 1985 report entitled *A History of the Aboriginal People of East Gippsland*, Kym Thompson wrote sensitively about GunaiKurnai culture and practice. The report notes that "Aborigines were actively modifying their environment, most particularly by using regular widespread burning to maintain advantageous non-climax vegetation patterns" (Thompson 1985: 52). Non-Aboriginal people have come to know some of the things that Aboriginal people knew all along. It is now understood that the GunaiKurnai fired the land as part of caring for Country, and that they did this with great knowledge and expertise. They knew when and what to burn, and how hot to set the fire.

Typically the literature on Gippsland written in the latter half of the twentieth century rarely mentioned the GunaiKurnai. When it did, the reference tended to be cursory, and sometimes derogatory (e.g. Spurrell 1976: 1). In such histories, often little more than a catalogue of "White man's progress", there was no room for discussion of GunaiKurnai culture, let alone burning practices. Other histories mentioned GunaiKurnai culture, but as a dead relic of a distant past. A history kit prepared for Bairnsdale school students in 1981 included information lamenting the destruction of the GunaiKurnai, now “gone forever” (Douglas 1981: no page numbers).

7.6 Oral histories

It remains that the written records mentioning GunaiKurnai burning practices in the twentieth century are curiously thin. This literature review is not exhaustive, and no doubt there are worthwhile sources not captured in this report. Memoirs, including unpublished memoirs held in Gippsland families, might prove particularly important sources. An even more promising way to strengthen historical knowledge of GunaiKurnai burning practices may lie in oral history. It seems that much discussion of GunaiKurnai burning, especially in the twentieth century, never made it to the printed page.

Gippsland was one part of Victoria affected by the January 1939 “Black Friday” bushfires. In his landmark Royal Commission report into the fires, Leonard Stretton (1939) wrote of graziers’ knowledge of fire, and of an oral tradition. The following passage is from the environmental historian Tom Griffiths’ *Gippsland Heritage Journal* article about Stretton and his report:

> In the drier forests (but generally not the wet mountain ash forests which had less grass), graziers used fire as Aboriginal people had done: to keep the forest open, to clean up the scrub, to encourage a “green pick”, and to protect themselves and their stock from wildfire. In autumn a portion of each run was burnt. It was a tradition handed down over generations, sanctioned, as Stretton observed, by long usage. It was this habit of burning that generated increasing government opposition to the cattlemen and women. (Griffiths 2002: 10)

Griffiths adds: “The Royal Commission was nothing less than a full-scale enquiry into Australian bush culture. The language the settlers and farmers used—'burning to clean up the country’—was uncannily like that of Aboriginal people” (Griffiths 2002: 13).

When in the 1830s James Macfarlane drove cattle from the Monaro into what is now Victoria, he followed an ancient Aboriginal pathway. Both the Aboriginal inhabitants of the area, and Macfarlane and other cattlemen who used this path, had an interest in keeping the country clear. And they did so, up until recent decades. GunaiKurnai Elder Russell Mullett, speaking of the second half of the twentieth century, told us that cattlemen using Macfarlane’s Track would defer to Aboriginal knowledge and either follow instructions or ask their Aboriginal workers to set fires to keep paths open. In how many places in Gippsland might there be similar stories?

Only in recent decades, with tighter restrictions on the lighting of fires, has the bush around Macfarlane's Track closed in (Figure 7.2). Bill Gammage, who has written extensively about Aboriginal burning practices, including in Gippsland, was taken to Macfarlane's Flat by mountain cattlemen, members of families long established in the High Country. They told him about the spread of scrub in recent decades, and of how their forebears had relied on fire to keep country open. Their spoken memories match the knowledge shared by Russell Mullett.

…

Figures 7.2: Macfarlane's Track/Flat.

Chris and Jeanette Commins of Ensay North are graziers long established in the High Country. Their family has lived in and around the High Country since the 1840s, and have run cattle in Gippsland for the past 100 or more years. When James Lilburne Commins, Chris's grandfather, came to Ensay after the First World War, fire was part of Gippsland life. James Arthur Commins, Chris's father, grew up at Ensay in the 1920–1930s. He remembered smoke as ubiquitous and constant, including in summer: the haze came from bushmen burning off and from fires caused by lightning. Chris is sure that Aboriginal knowledge of fire has informed the practices of his family and, more widely, the burning methods of mountain cattlemen, with observation and anecdote the channels along which information has passed across cultures and generations. For instance, he remarks that fire should never burn so hot and high as to scorch canopy. Reducing canopy cover allows in light, which promotes "massive regrowth creating a thicket of scrub and elevated litter" (Chris and Jeanette Commins, personal communication, Ensay North 30 July 2021). The threat of intense crown fires informs how Chris and Jeanette manage land (Figure 7.3), and he takes an active interest in the application of the firestick and cool burning. For him the utility and need for such burning is obvious (Figure 7.4).

In a separate interview, Ewan Waller made exactly the same point: fire should not touch the tree tops. Waller and his forebears have farmed at Glenaladale since the nineteenth century. His grandfather, Tom Morrison, burned for green pick. He did this in January, and burned hot: several fires got away from him, with devastating effects. The bush taught Basil Waller, Ewan's father, to do otherwise. He knew to burn cool. He always carried a box of matches and in winter would drop fire to remove tussocks and blackberries. Very few fires escaped him because he knew how to burn. Ewan wants to see more cool fires in Gippsland and beyond. He uses the words "gentle" and "respectful" to describe the role of cool burning in caring for Country (Ewan Waller, personal communication, Bairnsdale 13 August 2021).

Figure 7.3. Photograph of land at Nunniong, taken in November. The difference in the length of the grass is the result of different grazing practices rather than burning. The photograph is included to show how mountain cattlemen and women adopt particular practices to manage country and fire risk. In a fire the patch at left would burn, while the patch at right and beyond the fenced area would not (photograph: Chris Commins).

Figure 7.4. Photograph of well-tended land on the Snowy Plain in the New South Wales High Country. The owner of this property used the firestick and grazing to care for Country. This land, privately held, is within the Kosciuszko National Park. It was not razed in the 2003 bushfires that afflicted the area, unlike much of the surrounding land. When surveying this country in the 1840s, Thomas Townsend, Deputy Surveyor General for New South Wales, wrote: "The blacks had visited the Snowy Mountains, a short time previously to us, for the purpose of getting 'Bogongs,' a species of moth, about an inch long, of which they are particularly fond; to obtain them they light large fires, and the consequence was, the country throughout the whole survey was burnt, leaving my bullocks destitute of food. During the time I was on the range the lower parts of the country were burning, and I was prevented, in almost every instance, from getting angles on any distant points, by the dense masses of smoke obscuring the horizon in all directions" (cited in Jurskis 2015: 68–69). (photograph: Chris Commins).

John Mulligan, born in Orbost in 1931, is a fourth-generation member of an East Gippsland settler family. The following quotes are taken from his recollections, published online on 3 February 2020 (Mulligan 2020). "When my grandmother's older sister (Mrs Coleman) first came to Mallacoota (ahead of the arrival of my grandparents), she said there was a small band of aborigines, who moved about, burning wherever they went". That was about 1890. When Mulligan was a boy, "fire was a constant in the bush. Everyone learned to live with it … Bush dwellers of the time had a completely different understanding of the necessity of regular fire in the environment and its acceptance, than that of the majority of people today". The effects of the 1939 Black Friday fires in East Gippsland, Mulligan recalls, were not as severe as elsewhere because graziers had been in the habit of burning regularly (Jurskis 2015: 166). They burned for feed and to keep the forest understorey clean.

Margaret Mulligan, John's wife, is another Gippslander who grew up with fire. Her family lived near Yarragon and later at Mallacoota. Margaret's father would tell his daughters to "Get on your horses and go out and burn today" (Margaret Mulligan, personal communication, Wangaratta, 11 August 2021). He knew when conditions were right, as did they. Margaret says that this knowledge was in-bred; they knew to burn in autumn, where to drop a match, and how to keep fire cool and contained.

Writing in 1952 about White settlers in the forests of the Cann Valley, D. M. Thompson noted "a tradition of fire handed down over three, and in places four, generations" (Thompson 1952: 2). Nowhere in his University of Melbourne thesis did he mention the GunaiKurnai. The Mulligans, too, draw no link to Aboriginal knowledge and practice. They see their own knowledge of fire as something inherent among older "bushies", people who know the land. In contrast, a 2010 paper produced by The Mountain Cattlemen's Association of Victoria did draw an explicit link. It connects the burning methods of graziers to Aboriginal practices, noting that from the 1830s onward mountain cattlemen "lit cool fires in the autumn after mustering" (The Mountain Cattlemen's Association of Victoria 2015: 3). Vic Jurskis, a forester of long experience with knowledge of Kosciuszko country, states that Aboriginal people, having gathered on the high plains to feast on Bogong moths, would burn the bush on their various ways home to ensure that access was maintained for the next season. He understands that alpine seasonal graziers adopted a similar practice: as they left the High Country in autumn, they burned grass to stimulate the next season's growth, and bush to keep country clear (Vic Jurskis personal communication by Zoom, 23 August 2021).

The oral histories of burning held within non-Aboriginal Gippsland families are worth recording (see Wakefield 1970: 153). They show that living close to the land, as farmers and cattlemen and women do, pushes people to learn something of Aboriginal practices, whether consciously or not. Necessity demands it. It follows that GunaiKurnai burning practices are probably better represented in the non-Aboriginal oral records than they are in the non-Aboriginal written records: this reliance on a spoken tradition offers a surprising parallel between White and Aboriginal histories of fire. How many cattlemen and other non-Aboriginal Gippslanders have drawn on GunaiKurnai burning practices without having thought to say so? How many burn without recognising a reliance on an older, Aboriginal tradition? Are there areas of Gippsland where GunaiKurnai burning knowledge has been applied continuously since White settlement without the written record taking notice? These and other questions about the transfer of burning knowledge from Aboriginal to non-Aboriginal communities are worthy of further exploration.

In collecting these sorts of histories, there is an example to follow. Daryl Tonkin was a White man who spent much of his life living with and learning from GunaiKurnai people. His partner and the mother of his children was Euphemia Mullett (née Hood), a GunaiKurnai woman. Their property at Jackson's Track near Drouin in West Gippsland became a home, workplace and haven for many GunaiKurnai families. Tonkin knew the bush and he knew fire. Late in life he began to commit some of his life story to paper, a decision that led to the celebrated book *Jackson's Track* (Tonkin and Landon 1999: e.g. 208). Until he began to share his memories, what he had learned of Aboriginal culture and practice remained hidden from all but his family. Tonkin was a remarkable and deeply unusual man, and it would be naïve to think that such accounts lie hidden around every corner in Gippsland. Equally, it would be foolish to think that his was the last word. There must be other such accounts, perhaps not as rich, but important nonetheless, to be added to the historical and written records of Aboriginal burning practices in Gippsland and the country beyond.

8. Eugene von Guérard on GunaiKurnai Country 1860–1861: Reading the story of fire in his landscape art

By Ruth Pullin

Introduction: The Junction of the Buchan and Snowy rivers

On 9 January 1861, Eugene von Guérard (1811–1901) sketched the magnificent view of the Snowy River at the point where, winding through hilly, forested country, it is joined by the Buchan River (**Figure 8.1**). This landscape was shaped by fire. The evidence is embedded in the fabric of the landscape as recorded by the artist—in the park-like openness of the woodland, the limited undergrowth, the distribution of the trees and the areas of patches of open grass. The templates for cool burn practices identified by Bill Gammage (2011) in his important book, *The Biggest Estate on Earth: How Aborigines Made Australia*, are visible in von Guérard's drawing. He saw and documented the open corridors of grass, framed by tree belts, that run down the steep east-facing slopes to the Snowy River. The grass on these corridors, the fresh pick generated by the application of cool burns, was designed to attract grass-eating mammals and to "clean Country"—to keep it healthy—as we now know from Aboriginal knowledge-holders. From the shelter provided by the tree belts, hunters could corral their prey down the steep corridors to the water. These grass corridors were, in effect, traps. The mosaics or patches of open grassland on the otherwise forested crest and west-facing slope of the ridge on the left of von Guérard's drawing, and on the hills in the middle distance, are also the result of cool burns; these grass patches, like the corridors, were designed to attract and ambush prey. An example of this was recorded for GunaiKurnai Country by the Church of England missionary the Reverend John Bulmer, who managed the Lake Tyers Mission Station at Bung Yarnda from 1862 to 1907. Bulmer recorded that "… in summer they set fire to a large tract of country and speared the animals as they were escaping from the fire. They also got many after the fire almost roasted enough for eating" (cited in Vanderwal 1994: 61). In the absence of evidence for changes in soil, microclimate or other conditions, Gammage (2011: 8–9, 21–95) suggests that patch-burning is the only viable explanation for the areas of open grass located in bushland observed by early colonists and colonial artists. The locations of such patches were changed over time to ensure that animals did not become wary of particular places, while also allowing for the bush to recover. The critical determinant for their location was the association of water, grass and forest (Gammage 2011: 61). In von Guérard's drawing, the grassy corridors lead to water, grass mosaics are on forested hills close to the river, and hills further from the water are densely vegetated.

Figure 8.1. Eugene von Guérard, *Junction of the Buchan River with the Snowy River. 9 January 1861* (1861), pencil and ink (from "Australian Sketches 1860–1861", Alexander Turnbull Library, Wellington, New Zealand, E-337-f-034).

Von Guérard's drawings as reliable records

While von Guérard's colleague Robert Brough Smyth was aware by 1878, that it was customary practice "to burn off the old grass and leaves and fallen branches in the forest, so as to allow of a free growth of young grass for the mammals that feed on grass" (Brough Smyth 1878: xxxiii), it is unlikely that in 1860 von Guérard understood that the grass necks and mosaics that he observed in GunaiKurnai Country were the result of fire practices followed by the Krauatungalung for thousands upon thousands of years. However, we can be sure that as he drew, working directly from "nature", he recorded exactly what he saw. These drawings, many of them elaborated with detailed notes, were his primary references, the documents he relied on for the paintings executed later in his Melbourne studio. For him, topographical accuracy was essential, and his success can be measured in a comparison between his drawing, *Junction of the Buchan River and the Snowy River*, and a photograph taken 160 years later from the same or very close vantage point (**Figure 8.2**). Descriptive notes refer to the "dark sheoaks" and "old wattle" that he saw there on the day, revealing his interest in botanical accuracy, and the reference to the "white foam" on the water caused by turbulence at the meeting of the two rivers, his attention to detail. Von Guérard would annotate many of his drawings, often in old German, with precise details about features of the scenes he depicted, such as the light and shadows, the colours of the foliage and grassy patches, and the types of trees present. These details, which informed his studio works—oil paintings, lithographs and presentation drawings—often appear to have been recorded for their own sake; they reflect the artist's innate curiosity and interest in the world he saw.

Figure 8.2. Junction of the Buchan River with the Snowy River, photographed in 2019 a few months before the 2019–2020 Gippsland bushfires (photograph: Bruno David).

All the sketches and drawings discussed in this chapter were drawn by von Guérard on the spot, directly in front of the subject portrayed. These on-site drawings were working documents, made for the artist's own reference. He depicted what he saw without making pictorial or compositional changes to the scene—such alterations were simply not required. Slight variations to a composition were often made in the studio, when the subject was transferred to canvas or prepared for printing as a lithograph, but the overall aim was to remain as faithful to the subject as possible, and to convey its essential "truth". Sometimes the features of a landscape were compressed slightly to fit the proportions of a canvas or the lithographic sheet or the mountain peaks slightly heightened for compositional reasons or dramatic effect. The most frequent changes appear in the foregrounds of the studio paintings, where a tree, a fallen log or a group of rocks may be introduced to frame a composition or to accentuate the foreground in order to enhance, by contrast, the illusion of pictorial depth. Von Guérard selected his drawing of the junction of the Buchan and Snowy rivers from "the hundreds of drawings suitable for publication" for his album of twenty-four lithographs, *Eugène von Guérard's Australian Landscapes* (1866–1868) (von Guérard 1870) (Figure 8.3). The drawing, at 32.3 × 52.8 cm including a narrow margin, is slightly wider than the lithographic image with its squarer dimensions of 33.0 × 50.5 cm. Here, as in many other works, von Guérard made subtle and almost imperceptible incremental shifts in, for example, the steepness of slopes, across the whole composition such that the topographical integrity of the view was not compromised.

Figure 8.3. Eugene von Guérard, *Junction of the Buchan and Snowy rivers, Gippsland, Victoria* (1867), colour lithograph. Plate 9 in *Eugène von Guérard's Australian Landscapes* (1866–1868), published by Hamel and Ferguson, Melbourne (National Gallery of Victoria, Melbourne).

The origins of von Guérard's "truth to nature"

"My wish was, even if not to create a complete work of art, then at least to put before the public views from this part of the world that demonstrate the character of the Australian landscape faithfully and with truth to nature" (von Guérard 1870, cited in Pullin 2011: 25). Von Guérard's passionate interest in nature, and his ability to depict it with precision and in minute detail, can be traced back to the early influence of his artist-father, Bernard von Guérard. At the time of Eugen's birth (he was christened "Johann Joseph Eugen von Guérard" and known as "Eugen"), in 1811, his father Bernard was a well-regarded painter of miniature portraits in Vienna. His subjects included high-ranking military men and royalty and aristocrats attached to the courts of Vienna and (later) Italy. In 1827, Bernard and his 16 year-old son Eugen set out on an open-ended sketching and painting trip to Italy. As father and son worked side-by-side, sketching in the Italian landscape, the young von Guérard learnt the skills of a miniaturist, honing his eye for detail, and becoming adept at capturing the minutiae of nature using hard, finely sharpened pencils, pen and ink and, in the studio, the smallest and finest brushes. Von Guérard's commitment to the faithful portrayal of nature developed further when, in Germany in the 1840s, he studied landscape painting under Johann Wilhelm Schirmer (1807–1863) at the highly regarded Düsseldorf Academy. Schirmer encouraged his students to paint nature with an "obedient, natural sense, that everything seen should be seen as it is, always with open eyes and a warm heart" (Schirmer 1833, cited in Eggerath 2003: 63; see also Pullin 2011: 78).

Humboldt, von Guérard and the meeting of science and art

Von Guérard's view of the natural world was profoundly shaped by the ideas of the brilliant German polymath, traveller and natural scientist, Alexander von Humboldt (1769–1859). The celebrated Humboldt had fired the imaginations of a generation, inspiring, among others, Charles Darwin, with his ground-breaking discovery of the "interconnectedness" of all aspects of the physical world. The impact of his ideas was felt around the world. Von Guérard was one of a cohort of eminent German artists and scientists, including the botanist, Ferdinand von Mueller (1825–1896) and the geophysicist, Georg von Neumayer (1826–1909), whose Australian careers were informed by Humboldt and his work.

Humboldt devoted an entire chapter of the second volume of his best-selling publication, *Cosmos: A Sketch of a Physical Description of the Universe* (1847), to the subject of landscape painting. He urged landscape painters to "seize" on "the true image of the varied forms of nature", to depict individual plant species with scientific accuracy, not introduced from afar into hothouses but in the context of their natural growing environments (Humboldt 1847: 452; 1849: 229). Along with other influential figures in Germany, notably the scientist, theorist and landscape painter Carl Gustav Carus (1789–1869), Humboldt argued that art and science were parallel and complementary disciplines, each capable of informing the other (Pullin 2011: 15). Together artists and scientists could provide complementary information about the natural world, its geomorphology and geological processes, soil and climatic conditions, plant species and their distribution and relationships in relation to latitude and elevation above sea level, and more. He saw that in one image the artist could communicate all this with an immediacy unavailable to the scientist, who may require thousands of words to convey the same information.

In Australia, and in keeping with the empirical methodology of Humboldtian science, the precise observation of landscapes, many of which were as yet unseen by European eyes, was fundamental to von Guérard's vocation as an artist. "Descriptions of nature", Humboldt argued, "may be defined with sufficient sharpness and scientific accuracy, without on that account being deprived of the vivifying breath of the imagination" (Humboldt 1847: 438). Von Guérard's drawings are alive with his wonder at the "natural" world as he experienced it on his sketching expeditions across southeastern Australia.

Travelling with scientists in GunaiKurnai Country: Howitt and Neumayer

Humboldt's ideas about art and science were realized in practice when von Guérard travelled alongside scientists and scientific men on their research and exploratory expeditions. He spent three of his seven weeks in GunaiKurnai Country in December 1860–January 1861 travelling with his friend, the experienced bushman, explorer, natural scientist and ethnographer Alfred Howitt (1830–1908) (Pullin 2018: 214–221). Joining Howitt and his party on their Government-sponsored gold-prospecting expedition into the rugged Gippsland Alps, gave von Guérard access to country he could not have penetrated alone (Figure 8.4). The scientifically oriented Howitt went on to make significant contributions to Australian botany—his *Eucalypts of Gippsland* was published in 1890—geology and anthropology. For von Guérard, this trip was an opportunity to see and discuss the landscape with an informed friend, a friend he knew well having travelled with him on an expedition through the rugged Yarra Ranges to Mount Baw Baw in 1858. The richness of their exchange is nowhere more evident than in von Guérard's large pencil drawing, later reworked in ink, of the Moroka River gorge (Figure 8.5). It is a drawing of extraordinary detail and complexity, geological precision and power. Howitt, recounting their experiences on that day, described being "suddenly brought up by a precipice of three hundred feet which runs sheer into the river—which just beyond shoots over a fall of perhaps 30 feet". While the men are attempting to navigate a way forward, one of them "looking very much like a fly crawling up a house side" as he clambers up a precipice, "De Guérard sits down to sketch the rocks—I sit with him and light my pipe" (Howitt 1860). Late in 1862, this time travelling with another good friend the Humboldtian scientist Georg von Neumayer and his party on a magnetic survey of northeast Victoria, von Guérard again passed through

GunaiKurnai Country when the party skirted through the northern-most reaches of Brabralung country on their approach to Mt Kosciuszko from the south.

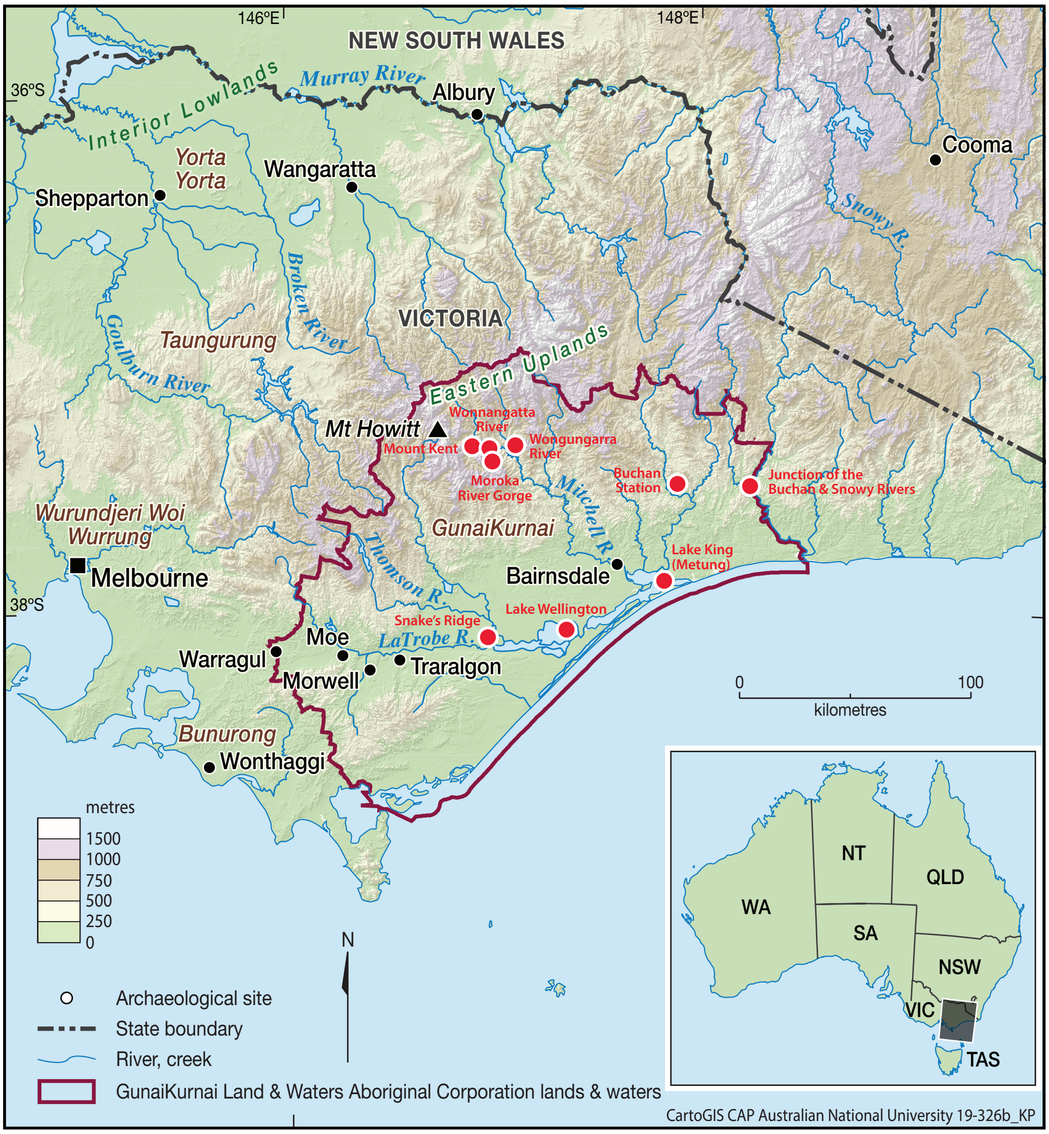


Figure 8.4. Places where Eugene von Guérard drew landscapes in GunaiKurnai Country, as discussed in this chapter.

Figure 8.5. Eugene von Guérard, *Moroka River near Mt Kent Gippsland. 13. Dec. 1860* (1860), pencil and ink. “Australian Sketches 1860–1861”. Alexander Turnbull Library, Wellington, New Zealand, E-337-f-017.

On the 1860–1861 Gippsland expedition, von Guérard filled all but the last four pages of his pocket-sized sketchbook with pencil sketches of GunaiKurnai Country, and he produced 35 larger drawings, most later finished in pen and ink, all now held in a bound album in the Alexander Turnbull Library in Wellington, New Zealand. The number and beauty of the drawings inspired by this trip accords with Howitt’s observation that the artist was in a “state of delight” as, between 1–20 December 1860, they trekked over and through the valleys of the Wonnangatta, Wongungarra and Crooked rivers, over the Snowy Bluff, into the Moroka Gorge and back to their base camp on the Wonnangatta River (Howitt 1860).

Records of cultural burns in the high country

Bill Gammage identified von Guérard’s *View of the snowy bluff on the Wonnangatta River, Gippsland Alps, Victoria* (1864) (Figure 8.6), as an example of the artist’s work in which evidence of fire patterns, in this case patches and mosaics, can be seen:

> At centre and right von Guérard shows three sloping clearings split by tree-filled gullies. They face northeast to catch the sun and bring animals to feed and warm. On them patch-burns located animals, and let hunters drive them uphill or headlong into a gully. Two clearings also carry lone trees spared by frequent grass fires, even when young. Perhaps rocks or backburning protected them. (Gammage 2011: 68)

Figure 8.6. Eugene von Guérard, *View of the snowy bluff on the Wonnangatta River, Gippsland Alps, Victoria* (1864), oil on canvas, 95.2 × 152.7 cm (National Gallery of Victoria, Melbourne).

The presence of areas of "beautiful meadowland" (Gammage 2011: 7), on otherwise forested land where no shift in aspect or soil conditions was evident, had baffled early European travellers in other parts of the country. What von Guérard understood as to the reasons for the existence of such grassy areas, we cannot know, but we can be sure that he saw them. He hinted at their existence in a double page pencil drawing of this view in his sketchbook (Figure 8.7) but a larger, more detailed drawing, if it existed, has not survived.

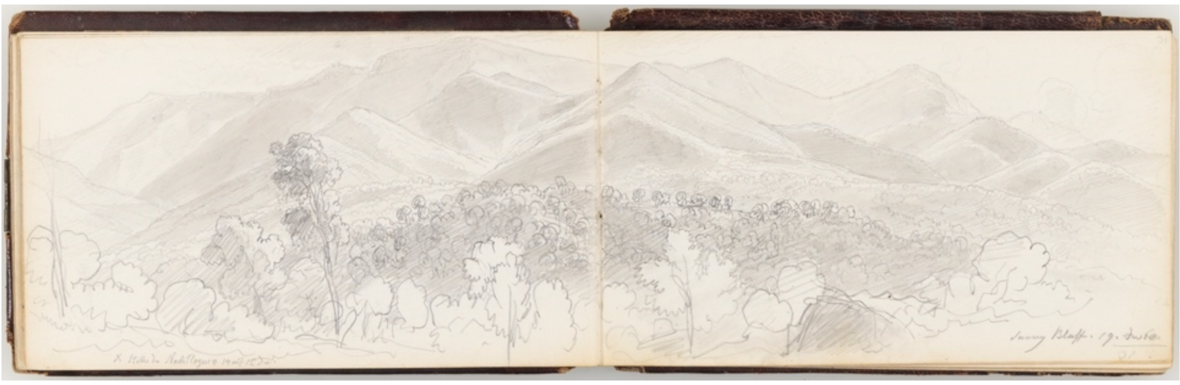


Figure 8.7. Eugene von Guérard, *Snowy Bluff 19 Dec. 1860* (1860). Sketchbook XXXII, No. 13–14 Australian, Dixson Galleries, State Library of New South Wales, Sydney, DGB16, v. 11, f. 31.

Figure 8.8. Eugene von Guérard, *Mt Kent, Gippsland 20 Dec. 1860* (1860), pencil and ink (from "Australian Sketches 1860–1861", Alexander Turnbull Library, Wellington, New Zealand, E-337-f-022).

Comparable mosaics of open grassland are clearly visible in a highly finished pencil, ink and wash drawing, *Mt Kent, Gippsland* (20 December 1860), drawn on the day after his sketch of the Snowy Bluff (Figure 8.8). The two grassy patches, on the sunny gentle lower slopes below, and to the left of, Mount Kent, are described by von Guérard in his notes as "gelbe Wiesen", yellow grasslands. They are identical to those that Gammage described as the result of patch-burns in von Guérard's *View of the snowy bluff on the Wonnangatta River*.

When von Guérard decided to make Mount Kent a subject of an oil painting, he opted for the view recorded in a very cursory pencil drawing in his sketchbook, rather than the more detailed drawing discussed above (Figure 8.9).

Figure 8.9. Eugene von Guérard, *Mt Kent and Part of the Snowy Bluff 1860* (1860). Sketchbook XXXII, No. 13–14 Australian, Dixson Galleries, State Library of New South Wales, Sydney, DGB16, v. 11, f. 32.

The open foreground of the painting, *Mount Kent, on the Wonnangatta, Gipps Land* (1873), like the sketchbook drawing, is populated with a few isolated eucalypts and a dead tree (Figure 8.10). They have grown tall and straight, reaching for the light, suggesting that as they grew they were surrounded by other trees. Now, as solitary individuals exposed to the light, epicormic branches have sprouted along the length of their trunks, and a handful of shrubs have sprung up on the grassy rise along which a mountain creek flows and where emus graze. Cool fires do not cause scrub to germinate or impact trees in the ways pictured here, suggesting that this area has been affected by a hotter fire, perhaps one caused by a natural event like a lightning strike, or European actions, or by another cause? Research has shown that "high country fire frequency" increased following the arrival of Europeans (Gammage 2011: 172, citing Banks 1997: 9–12).

Figure 8.10. Eugene von Guérard, *Mount Kent, on the Wonnangatta, Gipps Land* (1873), oil on academy board, 31.0 × 47.0 cm (private collection).

The steep slopes of the mountains depicted by von Guérard in his paintings and drawings are invariably densely vegetated, unlike the ridge-tops leading to the High Country and elevated plains, which are more open. This accords well with GunaiKurnai Elder Russell Mullett's knowledge of Country, passed down the generations, where the Old People, the ancestors of today's generations, "travelled mainly along the ridgelines up into the High Country". These "routes from the foothills to the mountains were marked by cosmological and other cultural associations", and were thus maintained as "healthy Country" including through cool patchwork fires by the GunaiKurnai (Fresløv and Mullett, in press). With further study it may be possible to argue conclusively that von Guérard's drawings show evidence of cool patchwork fires in the High Country. In one, *Wonangatta* [Wonnangatta] *River below the Junction of the Moroka River* (11 December 1860), what appears to be a series of open, grassy belts lined with trees can be seen on the slope, leading down to the river, and facing the viewer (Figure 8.11). While it may be that a site visit will reveal other explanations for these open, treeless corridors—perhaps a sequence of rock ridges—further investigation is warranted.

Figure 8.11. Eugene von Guérard, *Wonangatta* [Wonnangatta] *River below the Junction of the Moroka River, Thursday 11 Dec. 60* (1860), pencil and ink (from "Australian Sketches 1860–1861", Alexander Turnbull Library, Wellington, New Zealand, E-337-f-015).

Evidence of cultural burns on appropriated GunaiKurnai land

Howitt and von Guérard may have thought, as suggested by an art critic for the *Argus* in a review of von Guérard's 1876 version of the Snowy Bluff composition, "that they were the first human beings to penetrate into its [the Wonnangatta Valley] sequestered solitudes, as there was no trace of even a black man's presence" (Smith 1876: 5). By contrast, the imprint of European intervention was clearly evident in the GunaiKurnai country on which von Guérard travelled before and after his three weeks with Howitt in the Gippsland Alps, as were signs of the land management practices of its Traditional Owners. On his way to join Howitt, von Guérard had spent time on John King's station, Snake's Ridge, and Angus McMillan's Bushy Park. Both men commissioned paintings of the properties they now regarded as their own. Such paintings were a kind of affirmation of a property owner's legitimate claim to the land—a pertinent issue in the context of the *Land Sales Act* of 1860. Property portraits such as these could confer a level of respectability and status to the landowner, veiling over the realities of land theft and violence. King acquired the rights to the extensive Snake's Ridge run, which he had managed for some years, in 1851.

Figure 8.12. Eugene von Guérard, *From Mr John King's Snake's Ridge, Gippsland, 19 and 10 November, 1860* (1860), pencil on paper. "Australian Sketches 1861." Alexander Turnbull Library, Wellington, New Zealand, E-337-004.

Figure 8.13. Eugene von Guérard *Mr John King's Station, Gippsland* 1861, oil on canvas on board, 40.7 × 83.9 cm (private collection).

Rather than his homestead, it is his achievements as a pastoralist and a cultivator of the land that are celebrated in von Guérard's *Mr John King's Station, Gippsland* 1861 (Figure 8.13). However, it was not King who was responsible for the lush grasslands on which his cattle grew fat; they had been nurtured by GunaiKurnai over thousands and thousands of years. This was not a "natural" ecosystem after all, but one which had been managed. Evidence of the judicious use of fire (the "firestick farming" of Rhys Jones (1969)) to encourage the fertile grasslands and for hunting was visible when von Guérard recorded the scene in 1860. Like the "sawtooth tongues of forest" which "bite into grassland to let hunters ambush prey," which Gammage saw in von Guérard's lithograph, *The Sources of the River Wannon* (1866), here promontories of forest extend in bands over the grassland between King's station and the mountains (Gammage 2011: 59). This common template was recorded by von Guérard throughout western and northeastern Victoria.

After he left Howitt on 23 December 1860, von Guérard continued south along the Avon River to Lake Wellington and then east towards Buchan and the Snowy River, staying at and sketching properties on the way, including Bushy Park, where he sat with GunaiKurnai men and watched as, in the space of one and half hours, they made a canoe; Mr Bolden's Station, Strathfieldsaye; and Mr Smith's station, Lindenow. At Strathfieldsaye he was captivated by the beauty of Lake Wellington, and the abundance and diversity of the shrubs and grasses on its shoreline—including Marley Point, part of a dune system which GunaiKurnai Elder Russell Mullett (personal communication February 2021) points out was a burial ground for the people of this area (Figure 8.14). In his sketchbook study of Lake King, the artist recorded the series of silt jetties known by the GunaiKurnai as Wandin (boomerangs). These and other drawings hint at the significance von Guérard's drawings may hold for the future as records of GunaiKurnai Country, its land forms, lakes, rivers and vegetation, as they were in 1860–1861 (Figure 8.15).

Figure 8.14. Eugene von Guérard (1861), pencil and ink. Sketchbook XXXII, No. 13–14 Australia, “Gippsland 1860”. Dixson Galleries, State Library of New South Wales, Sydney, DGB16, vol. 11, f. 41. Left: *Strathfieldsaye. Station v. Mr Bolden. 2 Jan 61 Lake Wellington*. Right: *West of Lake Wellington Rosenith* [Roseneath] *2 Jan 61*.

Figure 8.15. Eugene von Guérard, *Mountains N.E. of Lake King, Gippsland January* (1861), pencil. Sketchbook XXXII, No. 13–14 Australia, “Gippsland 1860”. Dixson Galleries, State Library of New South Wales, Sydney, DGB16, vol. 11, f. 46.

Figure 8.16. Eugene von Guérard, *Point Metung & Exit of the Lakes to the Sea. Saturday 12 Januar 61* (1861). pencil and ink. “Australian Sketches 1860–1861”. Alexander Turnbull Library, Wellington, New Zealand, E-337-f-036

On the way to the junction of the Buchan and Snowy rivers

On the night before he reached the junction of the Buchan and Snowy rivers, von Guérard stayed with John MacLeod at Buchan Station. While in the area he sketched a view of Mt MacLeod—misspelt on his sketch as “Mac Claude”—in which three mosaics of grassland are clearly visible on the forested slopes that he described as bathed in “soft morning light from the east” (Figure 8.17). Did he, during his time at MacLeod’s station, take the opportunity to talk with the Brabralung people he met there, as he had with GunaiKurnai men at Bushy Park? By 1861, MacLeod was employing Brabralung men as stock riders, and his sister, reportedly, “taught local Brabralung women how to sew”. His property was thought to be “a good place for an Aboriginal reserve”, and MacLeod’s appointment as Honorary Correspondent of the Central Board for watching over the interests of the Aborigines was imminent (Howitt & Fison no date). Tulaba (Billy Macleod), a Brabralung man, was to be Howitt’s main informant, and worked as a stockman for the Mitchell and Snowy Rivers squatting stations near Buchan, Orbost and Bairnsdale (Mialanes et al. in press). In his large and detailed drawing of MacLeod’s station on the Buchan River, von Guérard portrayed a group of the people then living there, seated in front a bark shelter close to the main house (Figure 8.18).

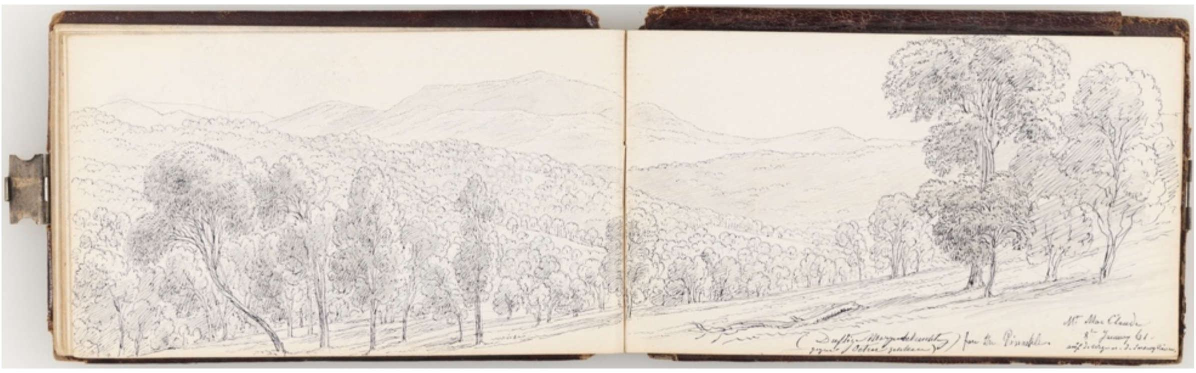


Figure 8.17. Eugene von Guérard *Mt Mac Claude* [MacLeod] *8 January 61* (1861), pencil and ink. Sketchbook XXXII, No. 13–14 Australia, “Gippsland 1860”. Dixson Galleries, State Library of New South Wales, Sydney, DGB16, vol. 11, f. 47.

Figure 8.18. Eugene von Guérard, *Buchan Station & Mt Dawson, 8 & 9 January 1861* (1861), pencil and ink. “Australian Sketches 1860–1861”. Alexander Turnbull Library, Wellington, New Zealand, E-337-f-033.

The next day, von Guérard followed the Buchan River to its junction with the Snowy River, where he quickly identified the optimum vantage point for his dynamic composition (see Figure 8.1). From an elevated position looking northeast, the Snowy River reads as a powerful arc as it sweeps around a promontory (described by von Guérard as a “half island”) to be joined by the Buchan River. The meticulous detail and topographical accuracy of his drawing and the related lithograph are remarkable documents, illustrating the precise condition of the country as it was on 9 January 1861, at a time of year that is today the peak of the bushfire season. Plant species, vegetation density and distribution, the relative openness of the woodlands, and the patches and necks of grassland flanked by forest, all indicative of the use of fire to manage the land, have been reliably recorded. The value of his record of the condition of this landscape, as it was in 1861, was brought into sharp focus by the bushfires that swept through this area at the end of 2019 and early 2020. At that time, Donald Graham who, with his wife Bronwyn, lived above the junction of the Buchan and Snowy rivers at the precise location where von Guérard had drawn this scene, observed of his lithograph and the physical landscape:

> He painted what was there and not what he thought should be there. And from that you can see what the landscape was like then …
>
> Over the last 150 years it’s changed from an open woodland because of the different practices or lack of burning if you like—a whole multitude of different approaches. It’s become forest and that ranges from pockets of rainforest to woodlands. But worse than that, it's a forest choked with an understory of bark, dead leaves, debris and fallen trees to the point you couldn't walk through it. (see Figure 8.2)

In 1870, von Guérard wrote of his “desire to imitate nature so well as in his power”, convinced that “for the future his paintings would have greater value” (von Guérard 1870). With the increasing awareness of the environmental significance of his work, and perhaps without von Guérard being fully aware of how the “natural” vistas he observed had in fact been created by countless generations of GunaiKurnai managers of Country, it seems he was right.

9. 20th and 21st Century Bushfires and Prescribed Burning in GunaiKurnai Country

By Jessie Buettel, Bruno David and Stefania Ondei

For this report we have used data on fire history and the spatial extent of bushfires and planned burns ("prescribed burning") recorded since 1903 from the State of Victoria, Department of Environment, Land, Water and Planning (DELWP). It is freely available through the Victorian Data Portal at https://discover.data.vic.gov.au. However, in these data, there were no records of fire events for the years 1903 to 1927 within GunaiKurnai Country, so here we report and display fire information from 1930 to the 2019–2020 fire season. This spatial layer also includes information on Traditional Owner fires and for the whole state of Victoria, there are 19 fires of this type, with the oldest recorded from September 2019. Further, more than half of these fires are less than 1 ha in extent, and the others are less than 5 ha. In GunaiKurnai Country, there were only two recorded Traditional Owner fires in this spatial layer, both dated 31 March 2021, one being 2.6 ha and the other 4.4 ha in area. In Sections 5, 7, 9 and 12 of this report, the data and maps shown pertain to bushfires and prescribed burns only.

Over the past 91 years, since 1930, much of the extent of the GKLaWAC RAP area (25,770 km^2) has been burnt by bushfires or prescribed burning at least once, with many areas having been burnt multiple times. Looking at the total area burnt by all fire events in GKLaWAC Country (some fires may have burnt the same location more than once), bushfires have burnt more than three-times the amount of land as prescribed burns since 1930. Bushfires burnt 17,548 km^2 of the GKLaWAC RAP area in the 70 years of records for the 20th century (1930–1999), compared with 16,111 km^2 in the past 20 years (2000–2020) (Figure 9.1). Even though this indicates a greater extent of burnt area in the 20th Century, this is largely driven by the huge bushfire event of 1939—the Black Friday Fires—that burnt 9031 km^2, just over half the total area burnt in 1930–1999 (Figure 9.2). By contrast, the area burnt by prescribed burning in the 20th century was nearly double that of the 21st (6720 km^2 vs. 3637 km^2, respectively; Figure 9.1).

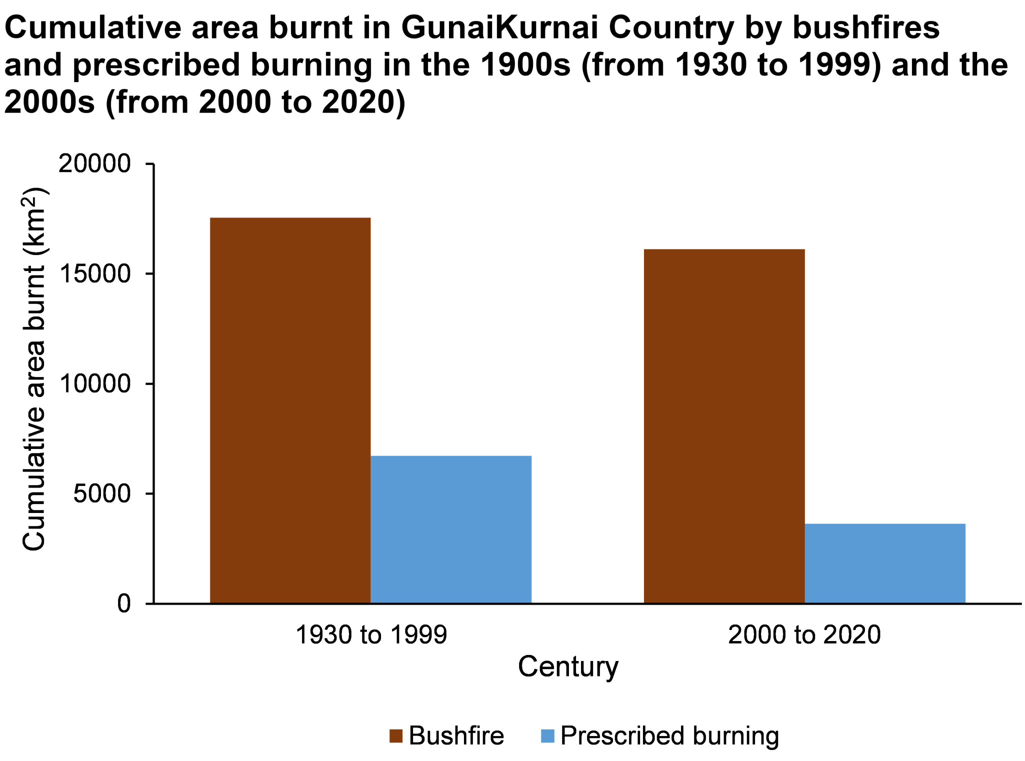


Figure 9.1. Extent of GunaiKurnai Country burnt (km^2) in the 1900s (1930 to 1999) and 2000s (2000 to 2020). Brown bars represent fires caused by bushfire events, blue bars by prescribed burns. All data sourced from https://discover.data.vic.gov.au. The total area burnt per century is cumulative, that is, the area burnt each year within GunaiKurnai Country is summed across all years for each century—in this case, some locations might have been burnt by bushfire or prescribed burns more than once.

The spatial extent of burnt landscape in GunaiKurnai Country has fluctuated over the past nine decades, with the pattern of spikes in bushfire extent being due primarily to individual, large-scale bushfire events (Figure 9.2). The decades with the largest area of land burnt was the 1930s, with the occurrence of the Black Friday fires (extent burnt in 1939 = 9030 km^2, almost 100% of the total area burnt by bushfires in that decade), followed by the 2000s and the Great Divide fires (extent burnt in 2007 = 6841 km^2, which is 74% of the total area burnt by bushfires in the 2000s), the 1965 Gippsland fires (extent burnt in 1965 = 4377 km^2, 75% of the total area burnt by bushfires in the 1960s), and finally the 2019–2020 Gippsland fires (extent burnt = 4992 km^2, 73% of the total area burnt by bushfires in the 2010s).

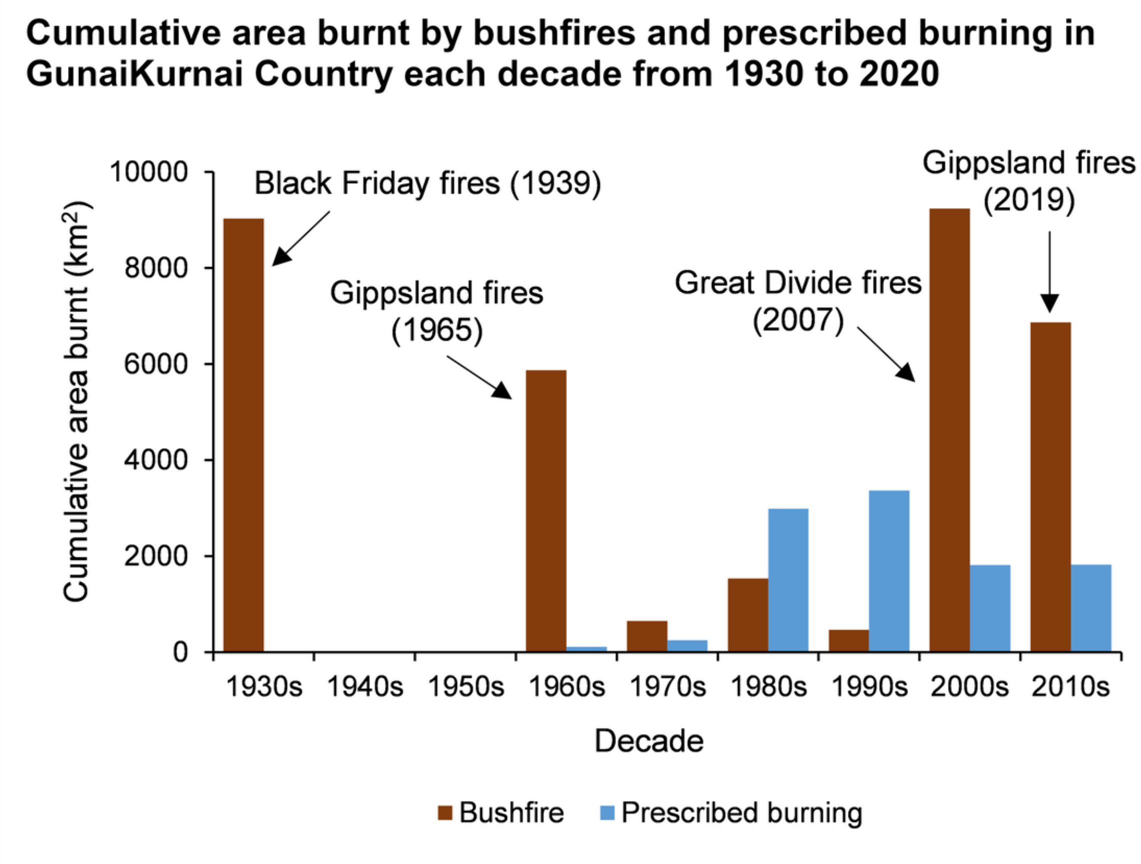


Figure 9.2. Extent of GunaiKurnai Country burnt (km^2) each decade from 1930 to 2020. The four largest fire events are indicated by arrows to their corresponding decades. The total area burnt per decade is cumulative, that is, the area burnt within GunaiKurnai Country each year is summed across all years for each decade—in this case, some locations might have been burnt more than once.

Bushfires were fewer and smaller, occurring in patches across GKLaWAC Country, in the 1970s, 1980s and 1990s than during all other decades on record (and particularly compared to the past 20 years) (Figure 9.3). The 1930s Black Friday fires were the largest bushfire event in spatial extent. No bushfires were recorded in GunaiKurnai Country in either the 1940s or 1950s (which is why this period is not represented in Figure 9.3). We can only speculate why, but this could be because of potential misreporting, or that the bushfires were small, the extent was unknown, or there simply were no bushfires in that 20-year period. Prescribed burning was first recorded in GunaiKurnai Country in 1966, and across all

55 years since, a total of 40% of GKLaWAC land (extent = 10,360 km^2) has been prescribed-burned (Figure 9.1). Each year an average of 0.77% of GunaiKurnai Country is prescribed burned, with some years seeing up to 2.8% (1987) of land thus burned. The 1980s and 1990s saw more land prescribed burned than any other decade, and also more area burned than by bushfires for these decades (Figure 9.2 and 9.3).

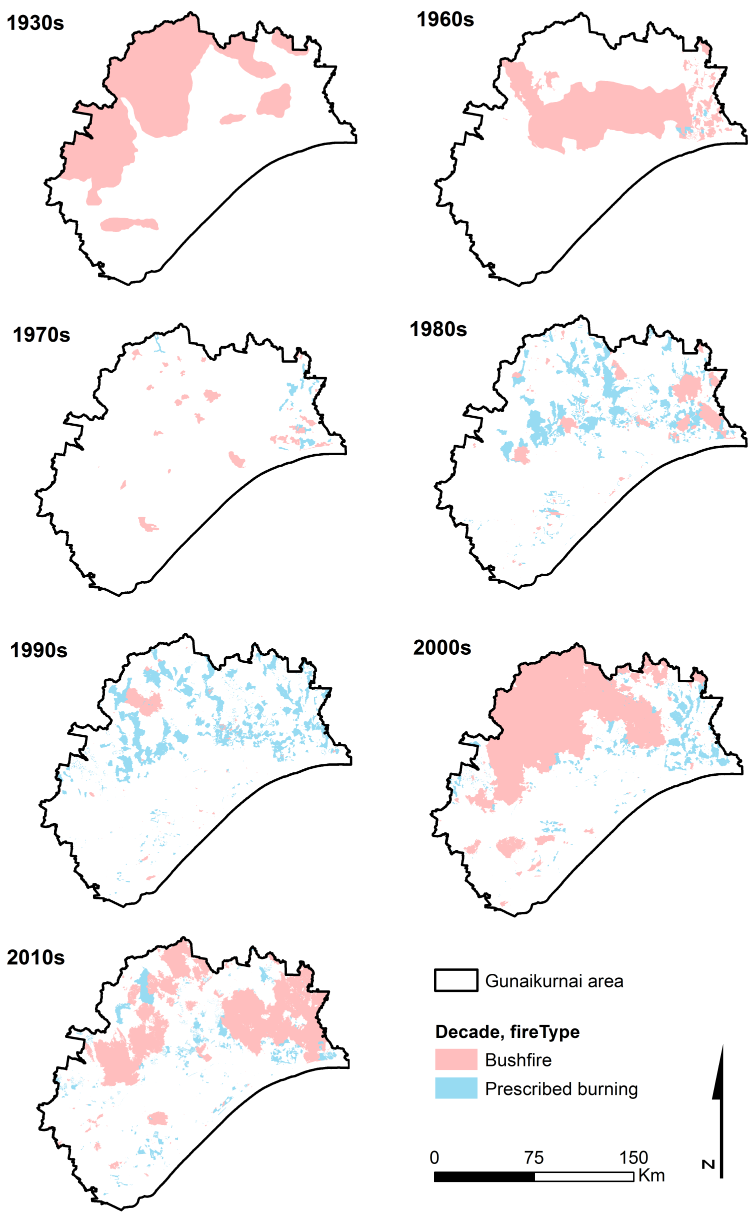


Figure 9.3. Location and extent of landscape fires across GunaiKurnai Country by decade, starting with the 1930s. Red shading indicates areas burnt by bushfires, blue areas by prescribed burns. Not shown here is the incidence of multiple burns within each decade.

Much of the extent of the fires (both bushfires and prescribed burning) have occurred in areas where the human footprint is higher (Figure 9.3 and 9.4). In other words, fires occur less frequently in areas with lots of infrastructure and where people live at higher densities – these are often the parts of the landscape that are more easily protected and contain low amounts of fuel for the fires (e.g., cleared landscapes) (ref). These are also the areas where higher densities of cultural sites have been reported (Figure 9.4 and Chapter 6). So where there is a higher human footprint, there is also higher land clearance, more registered cultural sites, and fewer fires.

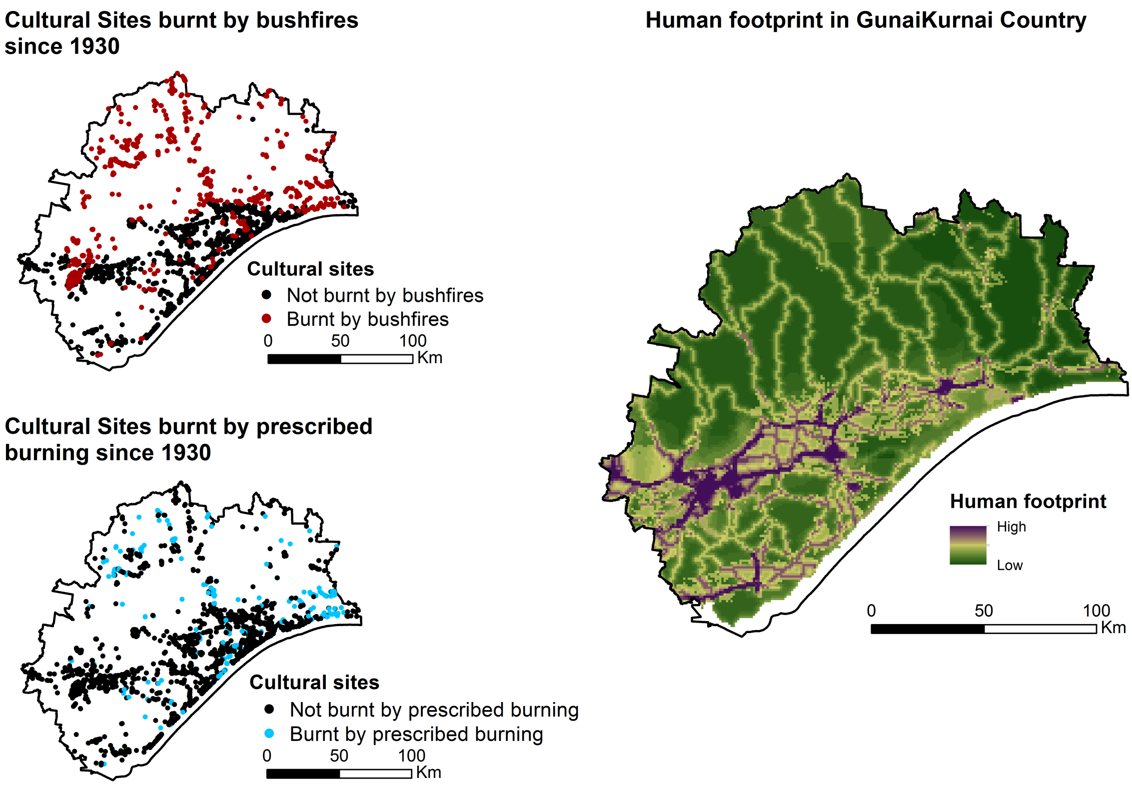


Figure 9.4. Fire history for cultural sites burnt by bushfires (top left) and prescribed burning (bottom left); the right-hand side map shows the relative density of human footprint (roads and other infrastructure, population densities, urban areas) across GunaiKurnai Country since 1930. All registered cultural sites are plotted. Data on cumulative human population pressure and footprints were sourced from the Socioeconomic Data and Applications Centre (SEDAC). The spatial (GIS) layer came from the 2018 release and was of a 1 km resolution. These data include the sum impacts of the following eight variables: Built-up environments, population density, electric power, infrastructure, crop lands, pastures, roads, railways, and

navigable waterways (Human Footprint, 2018 Release: Last of the Wild, v3 | SEDAC Socioeconomic Data and Applications Center | SEDAC (columbia.edu))

Detailed spatial data on the severity of bushfires were not collected until recent times. However, such data do exist for the 2019–2020 Gippsland fires that raged through northeastern GunaiKurnai Country and beyond (Figure 9.5).

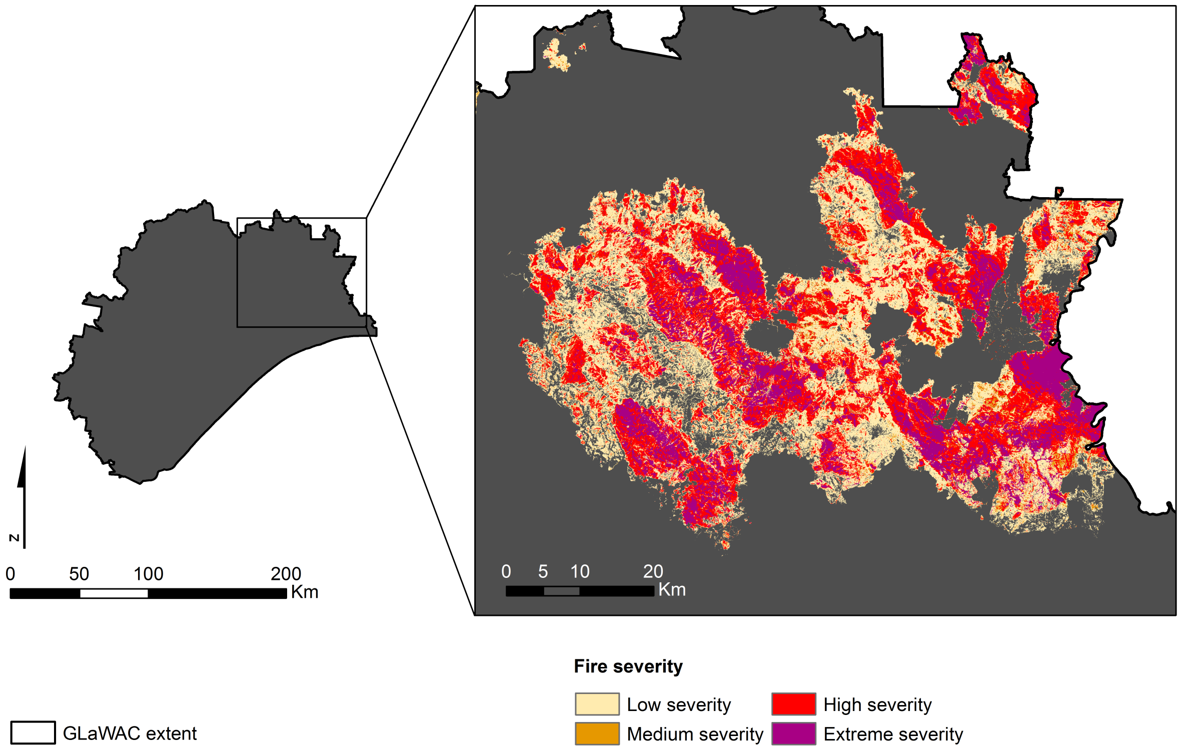


Figure 9.5. The extent of the largest bushfire that burnt across northeastern GunaiKurnai Country in 2019–2020.

10. Cultural Sites in GunaiKurnai Country

By Jessie Buettel, Jessie Birkett-Rees, Bruno David, Stefania Ondei, Joanna Fresløv and Robert Skelly

A key dimension of GunaiKurnai ecology and GKLaWAC's Whole-of-Country Plan is that the whole landscape is cultural (see Chapter 3). What are, then, 'cultural sites' if the whole landscape is cultural? For the purposes of this report, we refer to individual Aboriginal places as 'cultural sites' if they show archaeological evidence of past Aboriginal activities, or if they are associated with oral traditions, while not forgetting that the whole landscape is an artefact of cultural practice and Country in GunaiKurnai ways and management needs. We stress also that while we report on cultural sites listed in the Victorian Aboriginal Heritage Register, the vast majority of sites in GunaiKurnai Country remain unrecorded.

10.1. What are Cultural Sites?

Throughout this report, "cultural site" = "Aboriginal place" of the *Aboriginal Heritage Act* 2006, the primary Victorian legislation that protects Aboriginal heritage sites in the State of Victoria. Section 5 of the Act defines an Aboriginal Place as:

(1) For the purposes of this Act, an Aboriginal place is an area in Victoria or the coastal waters of Victoria that is of cultural heritage significance to Aboriginal people generally or of a particular community or group of Aboriginal people in Victoria.

(2) For the purposes of subsection (1), ***area*** includes any one or more of the following—

- (a) an area of land;
- (b) an expanse of water;
- (c) a natural feature, formation or landscape;
- (d) an archaeological site, feature or deposit;
- (e) the area immediately surrounding any thing referred to in paragraphs (c) and (d), to the extent that it cannot be separated from the thing without diminishing or destroying the cultural heritage significance attached to the thing by Aboriginal people;

(f) land set aside for the purpose of enabling Aboriginal ancestral remains to be re-interred or otherwise deposited on a permanent basis;

(g) a building or structure.

When cultural sites are recorded, they are commonly divided into two types, based on the kind of information they are known from:

- *Archaeological sites*, which have material remains from past cultural activities (e.g., stone artefacts, animal bones or shell from food remains, fireplaces, Ancestral remains, etc.). It is these physical remains of the activities of the Old Ancestors that archaeologists usually study to try to understand the past.
- *Story places*, where community members hold knowledge or memories of past events or of a place's cultural significance. That knowledge is sometimes kept confidential by individuals, families or larger groups, or can be held by only men or women, or by Elders, for example; or sometimes it is more general knowledge that can be broadly known and shared by the wider community.

The *Aboriginal Heritage Act* 2006 refers to such knowledge held in oral traditions as 'intangible heritage', which the Act defines in Section 79B as:

(1) For the purposes of this Act, Aboriginal intangible heritage means any knowledge of or expression of Aboriginal tradition, other than Aboriginal cultural heritage, and includes oral traditions, performing arts, stories, rituals, festivals, social practices, craft, visual arts, and environmental and ecological knowledge, but does not include anything that is widely known to the public.

(2) Aboriginal intangible heritage also includes any intellectual creation or innovation based on or derived from anything referred to in subsection (1).

Therefore, while the traditional knowledge held by GunaiKurnai about cultural places is deemed "intangible heritage", the places themselves are held as Aboriginal Places under the Act. Some sites can be both archaeological (with artefacts left by the Old Ancestors) and story (where oral traditions are held) places (i.e., Aboriginal places with intangible heritage).

There are many different types of cultural sites in GunaiKurnai Country (as indeed there are across all of Australia), and while members of the GunaiKurnai community, and trained archaeologists, have long known this, many outsiders have remained oblivious to their existence, including many landscape management authorities. Furthermore, while there are probably tens or hundreds of thousands of GunaiKurnai sites across GKLaWAC Country, most—such as stone artefact scatters—lie on or buried under the ground and can thus be hard to see by those not taught to recognise them, or remain completely hidden from view. For this reason, systematic archaeological surveys, the recording of oral histories, and, more rarely, archaeological excavations are undertaken to systematically identify and record the location and contents of cultural sites. Such cultural sites are referred to in the *Aboriginal Heritage Act* 2006, the Victorian legislation that defines and purports to protect cultural sites, as "cultural heritage places". Some sites (i.e., cultural heritage places) can be very small, the location of a single artefact for example, or they can be very large, such as a whole ridge that formed a travel route. When recording and analysing cultural sites, it is therefore important to define exactly what kind of place is being talked about.

The *Aboriginal Heritage Act* 2006 and the *Aboriginal Heritage Regulations* 2018 identify parts of the landscape deemed by Aboriginal Victoria to be more likely to contain archaeological sites. These areas of "cultural heritage sensitivity" are presented in the Aboriginal Cultural Heritage Register Information System (ACHRIS: https://achris.vic.gov.au/#/onlinemap), with these parts of the landscape being given preference in cultural heritage management (CHM) assessments. Archaeological sites located during archaeological surveys, including CHM assessments, are registered in the State-run Victorian Aboriginal Heritage Register (VAHR). Given that the information in the VAHR records was gathered using the parameters set out in the *Aboriginal Heritage Act* 2006 and the *Aboriginal Heritage Regulations* 2018*,* the existing VAHR record is inherently biased toward areas that are considered to have greater "cultural heritage sensitivity" under the Act and Regulations. The list and distribution of known and registered GunaiKurnai sites is thus skewed towards registered sites in areas perceived by Aboriginal Victoria to be more sensitive or threatened parts of the environment.

The information about cultural sites in GKLaWAC Country used in this report was sourced from the VAHR. We understand that the VAHR does not view archaeological sites in the same way as a GunaiKurnai person might. The VAHR information consists of an eight-digit number for each registered cultural site, geographic coordinates identifying the location of each site, and a site category assigned according to the categories defined in the VAHR. Additional, qualitative information is provided on a "site card", which is the record produced by the person recording the site for the purposes of registration. The amount of detail provided on these site cards is not uniform; the main differences appear to relate to the year in which a given site card was produced and the person recording the information. The implication of the varied quality of detail provided in the site cards is that we cannot filter the information equally, across all of the records, to improve the current categorisation of archaeological sites.

The VAHR classifies sites into 11 types:

- Aboriginal Ancestral Remains
- Aboriginal Cultural Place
- Aboriginal Historical Place
- Aboriginal Object Collection
- Artefact Scatter
- Earth Feature
- Quarry
- Rock Art
- Scarred Tree
- Shell Midden
- Stone Feature

The definition of each VAHR site type has changed over time. For instance, prior to 2012, an archaeological site with stone artefacts could be registered as an "Artefact Scatter" or as an "Isolated Artefact". In 2012, the Office of Aboriginal Affairs Victoria introduced a new system for describing and registering areas where fewer than 10 stone artefacts were found within an area of 100 m^2 as "Low Density Artefact Distributions" (LDAD) (Spry 2016). LDADs represent an additional category to the Artefact Scatter listed above. This change in definition is problematic. In relation to understanding the distribution of sites across the landscape, it means that sites recorded before and after 2012 are spread into two or more site types, not because the sites are necessarily different in their characteristics, but simply because they were recorded using different terminology. For the purposes of this report, LDADs have been grouped with Artefact Scatters; this choice was necessary given the nature of the information at our disposal, rather than being based on the qualitative characteristics of these sites.

It is also important to note that despite explicit definitions and instructions, the terms used in the VAHR categories, and the ways in which archaeological sites are grouped or divided, are not always uniformly agreed on by all its users. This is the way the existing information about archaeological sites is presented in the VAHR records, and therefore the official VAHR categories and registrations are used in our research.

Aboriginal Ancestral Remains. "Aboriginal Ancestral Remains" are sites where human burials occur.

Aboriginal Object Collection. An "Aboriginal Object Collection" is defined as any Aboriginal object either held in private collections, in the collections of local museums or historical societies, or reburied on Country. In cases where objects have been returned to Country, the location recorded in the VAHR will represent the location of reburial. In cases where objects remain in a collection, the location of the custodian of the collection (such as a museum address) may be listed. This category was previously known as "Artefact Collection".

Artefact Scatter. "Artefact Scatters" are concentrations of stone artefacts seen on the ground surface. They were produced by the activities of the Old Ancestors during camping, tool production and other activities in the course of daily life. For an archaeological site to be recorded as an Artefact Scatter, stone artefacts must be present, but other kinds of artefacts such as food remains (e.g., animal bone, shell), charcoal or ochre may also occur in the same sites. Although Artefact Scatters are numerous across the landscape, no two sites are identical. Such sites can also provide information about interactions between disparate groups across the landscape (e.g., through the presence of imported stone and materials that may have been traded in) and cultural changes over time (e.g., through changes in artefact types or in the technologies employed to make them). An Artefact Scatter can be the result of a single event or activity, or it can indicate places that people returned to over long periods of time. Currently, by definition an Artefact Scatter consists of a concentration of at least 10 stone artefacts/m^2, and can be anything from 1 m to kilometres long.

Low Density Artefact Scatter (LDAD). As noted above, this type of Artefact Scatter first began to be used in the VAHR in 2012, in order "to facilitate a streamlined recording process for lower densities of artefacts" (Aboriginal Victoria 2013). It therefore only represents more recently registered Artefact Scatters with low densities of stone artefacts. LDADs are difficult to analyse, because in reality they could be single artefacts or very large sites with hundreds or even thousands of sparsely distributed artefacts spread across a large area up to many kilometres long (i.e., they could represent many different scatters of artefacts all under the one term).

Earth Feature. "Earth Feature" is a diverse category including earthen rings, mounds, banks, ditches, canals and trenches. Earthen rings are rare in the VAHR and are generally identified in these records with ceremonial functions. Mounds are distinguished as the result of long-term occupation of a single location and frequently incorporate occupational material such as charcoal, clay heat retainers or stone artefacts. Hearths and ovens are also identified as "Earth Features", as are "soil deposits" and "soil features". Soil deposits are considered to be accumulations of stratified cultural material, while soil features are defined as the result of soil removal, such as pits or postholes.

Quarry. "Quarries" are defined as the locations of sources of stone, ochre (technically iron oxide) or mineral pigment(s) that have been procured or extracted by people in the past. Extraction methods can include excavation and breaking, thermal fracturing or flaking, with evidence for the method used typically found on the remaining source stone or material. Quarries exhibit evidence of one or several of the following activities: material extraction, surface collection, transport and reduction or processing. As such, a quarry may also be the location of an Artefact Scatter.

Rock Art. "Rock Art" sites are defined as places where images have been produced on rock surfaces. These images may be produced either by the addition of pigment(s), sometimes referred to as "pictograms", or by selective removal of the rock surface, also known as "petroglyphs". These images may be isolated or present in multiple locations ("panels") on a rock face. In Victoria, sandstone, granite or limestone are the most common stone types on which Rock Art places were produced. The VAHR draws on the Australian Rock Art Research Association for guidance on recording motifs, forms and designs.

Scarred Tree. “Scarred Trees” are trees with sections of bark deliberately removed by the Old Ancestors, for the creation of shields, shelters, tools, containers, and bark canoes for transport across the lakes and along the rivers. The scars on the trees can vary in size, in keeping with the multiple purposes for which the bark was removed, but they are typically regular in shape and often have parallel sides and pointed or rounded ends. Scarred Trees are mature trees most frequently located along rivers and lakes. Some Scarred Trees in Victoria have been carved, containing designs cut into the wood.

Shell Midden. “Shell Middens” contain the remains of shellfish harvested by the Old Ancestors. These shell accumulations are called “middens” in the VAHR records and by most archaeologists. Shell Middens occur in a range of locations: they can be found as layers of shell exposed in dunes and river banks, or as shell scatters exposed on surfaces, sometimes through erosion. In addition to shell, which is typically the most common kind of item found in Shell Middens, such sites may also contain fish bone or the bones of marine (e.g., seal) or terrestrial (e.g., kangaroo) animals, usually as food remains. Hearth stones and charcoal from fireplaces may also be found in, or in association with, Shell Middens.

Stone Feature. “Stone Features” are defined by their primary construction material. This category takes in several types of features that may have had significantly different functions. “Stone Features” may represent way- or boundary-markers, such as cairns, or may be related to resource procurement and production, such as fish or eel traps, or grinding grooves used to sharpen stone implements. Subdivisions within this category include the term “Stone Arrangement”, to be used for a feature that was intended for a ceremonial function, and the term “Stone Structure”, used to designate a feature likely to have been a dwelling or shelter. Such dwellings may be those constructed by the Old Ancestors, or stone buildings associated with Aboriginal people during colonial times.

10.2. Cultural Sites in GunaiKurnai Country

There are 2698 registered cultural sites in GKLaWAC Country, including the 11 major VAHR site types: Aboriginal Ancestral Remains, Aboriginal Cultural Place, Aboriginal Historical Place, Aboriginal Object Collection, Artefact Scatter (including LDAD), Earth Feature, Rock Art, Scarred Tree, Shell Midden, and Stone Feature (Table 10.1; see Section 6.1 above for descriptions of each site type). There are many registered cultural sites in GKLaWAC Country that contain more than one site component type (Table 10.2). By far the most numerous site types are Artefact Scatters, Low Density Artefact Distributions, Scarred Trees, and Shell Middens (Tables 10.1, 10.2).

Table 10.1. Number of registered cultural sites in GunaiKurnai Country.

Site type	Number of sites
Aboriginal Ancestral Remains (Burial)	10
Aboriginal Ancestral Remains (Burial) & Aboriginal Historical Place	1
Aboriginal Ancestral Remains (Burial) & Artefact Scatter & Shell Midden	4
Aboriginal Ancestral Remains (Burial) & Shell Midden	1
Aboriginal Ancestral Remains (Reinterment)	1
Aboriginal Cultural Place	1
Aboriginal Historical Place	13
Aboriginal Historical Place & Artefact Scatter	1
Artefact Scatter	1645
Artefact Scatter & Aboriginal Ancestral Remains (Burial)	6
Artefact Scatter & Earth Oven	1
Artefact Scatter & Grinding Grooves	2
Artefact Scatter & Hearth	4
Artefact Scatter & Hearth & Shell Midden	1
Artefact Scatter & Hearth & Subsurface	1
Artefact Scatter & Quarry	3
Artefact Scatter & Rock Art	1
Artefact Scatter & Rock Art & Subsurface	2
Artefact Scatter & Shell Midden	145
Artefact Scatter & Shell Midden & Subsurface	2
Artefact Scatter & Subsurface	37
Bora Rings	1
Grinding Grooves	20
Grinding Grooves & Quarry	1
Low Density Artefact Deposit	18
Low Density Artefact Distribution	145
Mound	1
Object Collection	34
Quarry	10
Scarred Tree	387

Shell Midden	195
Shell Midden & Subsurface	4
Total sites	**2698**

Table 10.2. List of the types of site components found in GunaiKurnai Country and the number of sites in which they occur. Some sites may have more than one component.

Site component	Number of sites in which it occurs
Stone Feature	23
Shell Midden	353
Scarred Tree	388
Rock Art	3
Quarry	14
Object Collection	96
Low Density Artefact Distribution	359
Low Density Artefact Deposit	18
Earth Feature	53
Artefact Scatter	1827
Aboriginal Historical Place	15
Aboriginal Cultural Place	1
Aboriginal Ancestral Remains (Reinterment)	1
Aboriginal Ancestral Remains (Burial)	22
Total	**3173**

10.3. Where are the Cultural Sites in GunaiKurnai Country Found?

Cultural sites are fragile and often very susceptible to damage by people and environmental disturbance, especially when sites are exposed as surface exposures. Cultural sites are particularly subject to damage or destruction when destructive events operate over large spatial scales and impact the landscape quickly, such as bushfires. It is important to understand and recognise not only where these cultural sites are located, but also the characteristics of the landscape that surrounds them, so that we can better understand the impacts that disturbances like fires will have on site and artefact preservation, and their potential destruction. Post-fire management decisions can also lead to the unintentional damage of cultural sites if they are not recognised, as documented by a number of post-fire reports over the past 20 years.

The 2710 registered cultural sites are distributed across the entire length and breadth of GunaiKurnai Country (Figures 10.1, 10.2). There are, however, distinct locations with higher densities of registered cultural site types and artefacts, as highlighted by areas of dark red in the density plot on Figure 10.1. These high-density clusters of a number of site types are located along the Gippsland Lakes region (Lakes Entrance) and Traralgon and Morwell—unsurprisingly, areas of high concentrations of people and urban infrastructure today.

Although the registered cultural sites are distributed across the entirety of GunaiKurnai Country, it is also clear that different site and artefact types have been found in some areas and not in others, with a main pattern being very few site types in the north of GunaiKurnai Country (Figure 10.1). Artefact Scatters (surface) are the most numerous and widespread of all site types. Scarred Trees are mainly known from closer to the coast, with the occasional occurrence in the north and southwest, while Shell Middens are found exclusively near the coast (Figure 10.2).

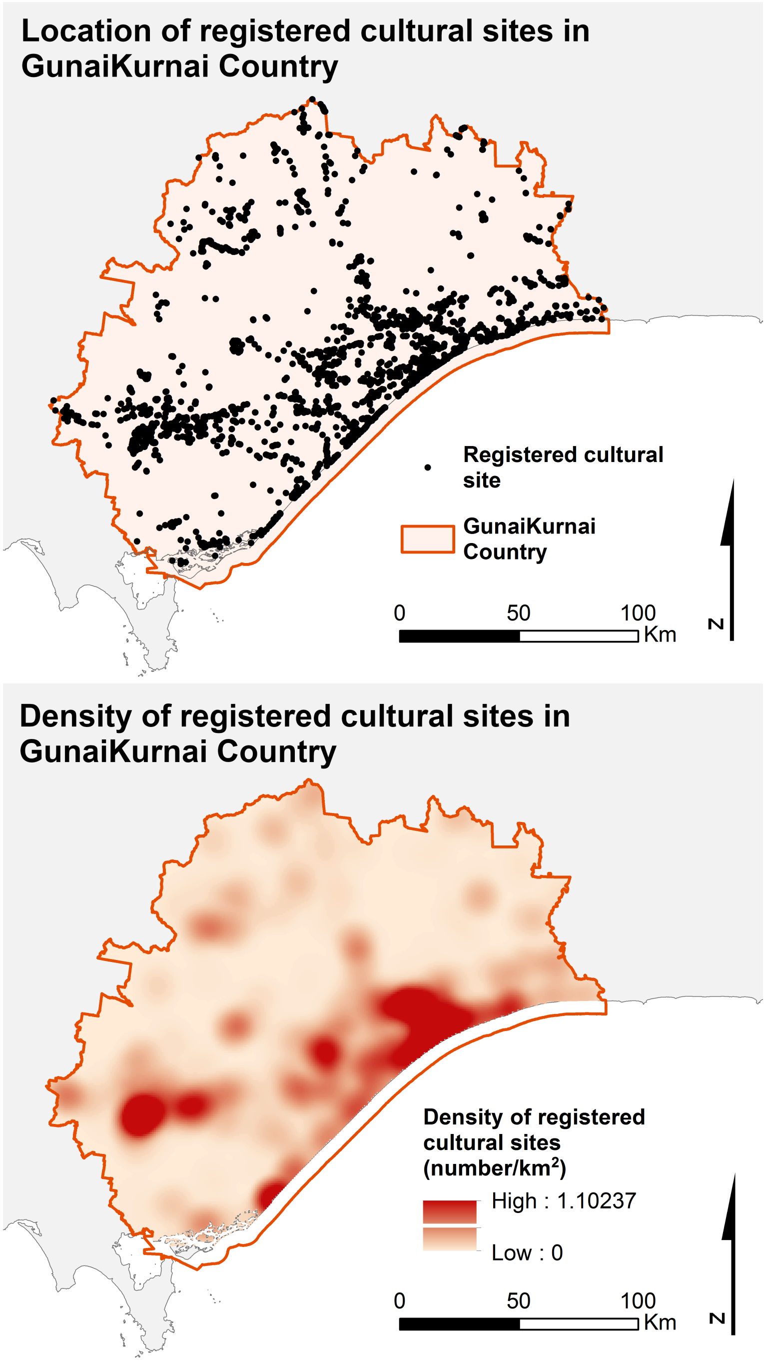
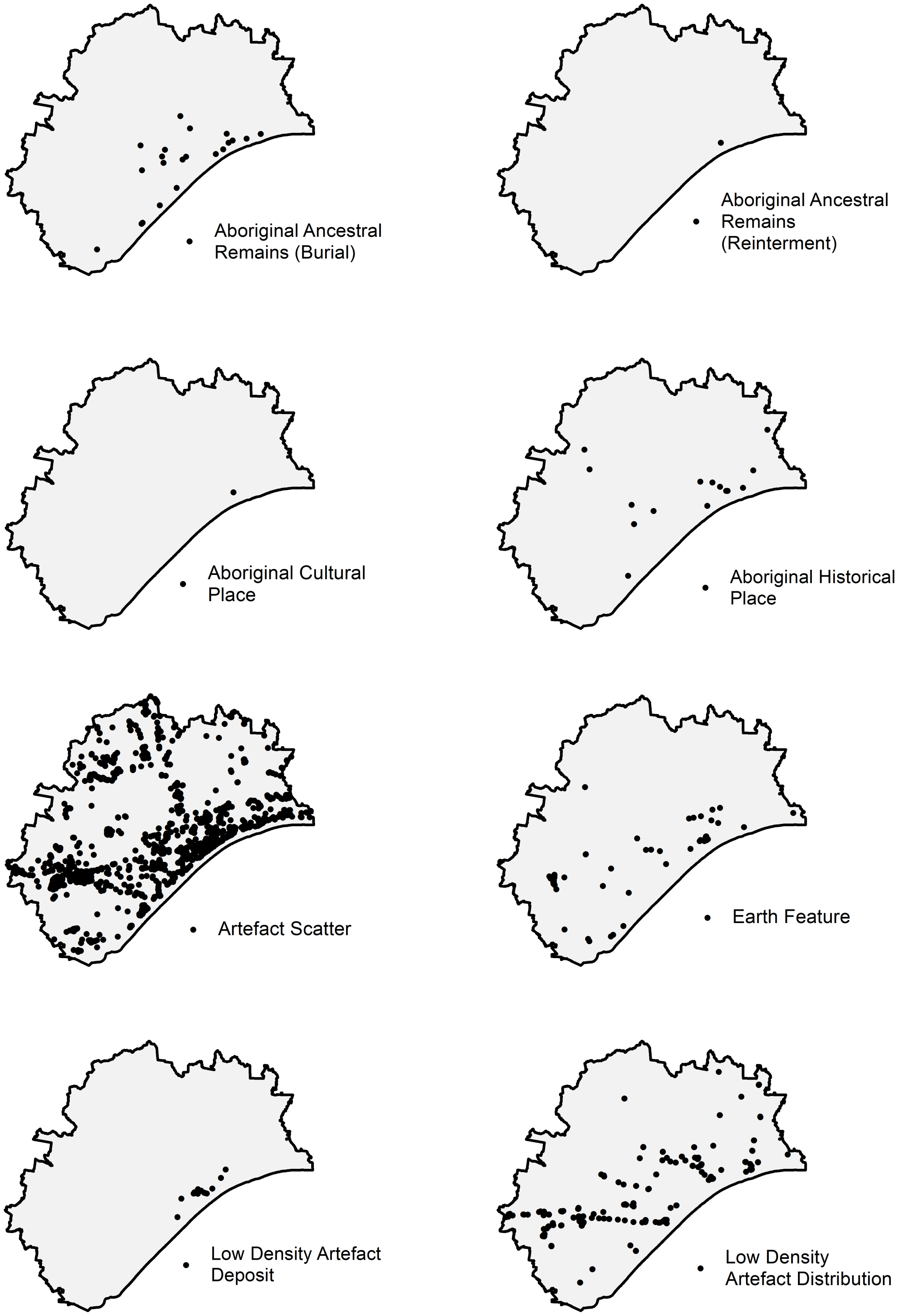


Figure 10.1. Location of all 2968 VAHR-registered cultural sites in GunaiKurnai Country. Top: Individual registered cultural site locations plotted. Bottom: Density map expressed as number of registered cultural sites per km^2.


Aboriginal Ancestral Remains (Burial)
Aboriginal Ancestral Remains (Reinterment)
Aboriginal Cultural Place
Aboriginal Historical Place
Artefact Scatter
Earth Feature
Low Density Artefact Deposit
Low Density Artefact Distribution

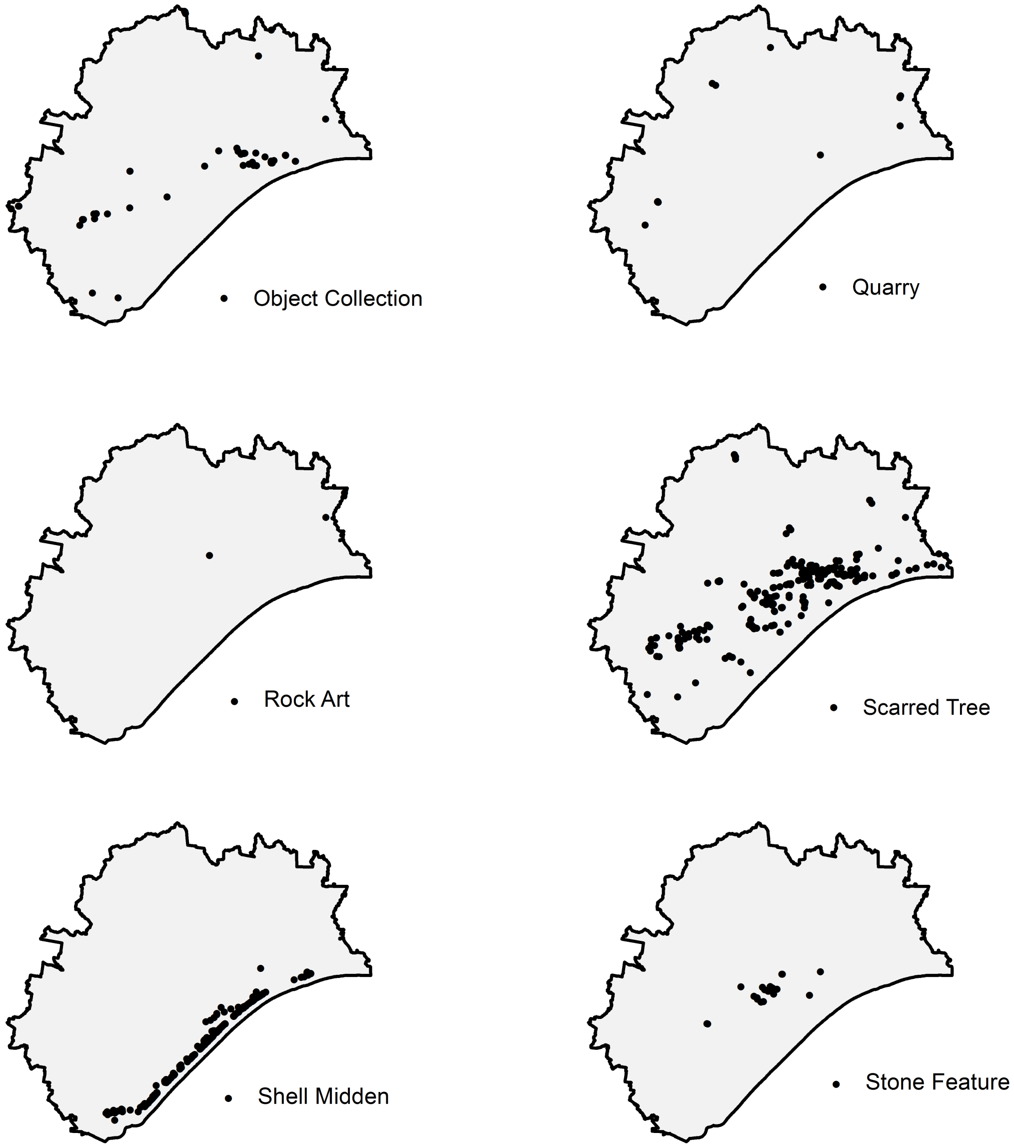


Figure 10.2. Location of the 14 different site component types across GKLaWAC Country. Each dot represents a registered cultural site that contains that component type. Some registered cultural sites will have more than one component type (the counts of each component type can be found in Table 10.2).

10.4. Distribution of registered cultural sites by surface geology (rock types and surface sediments)

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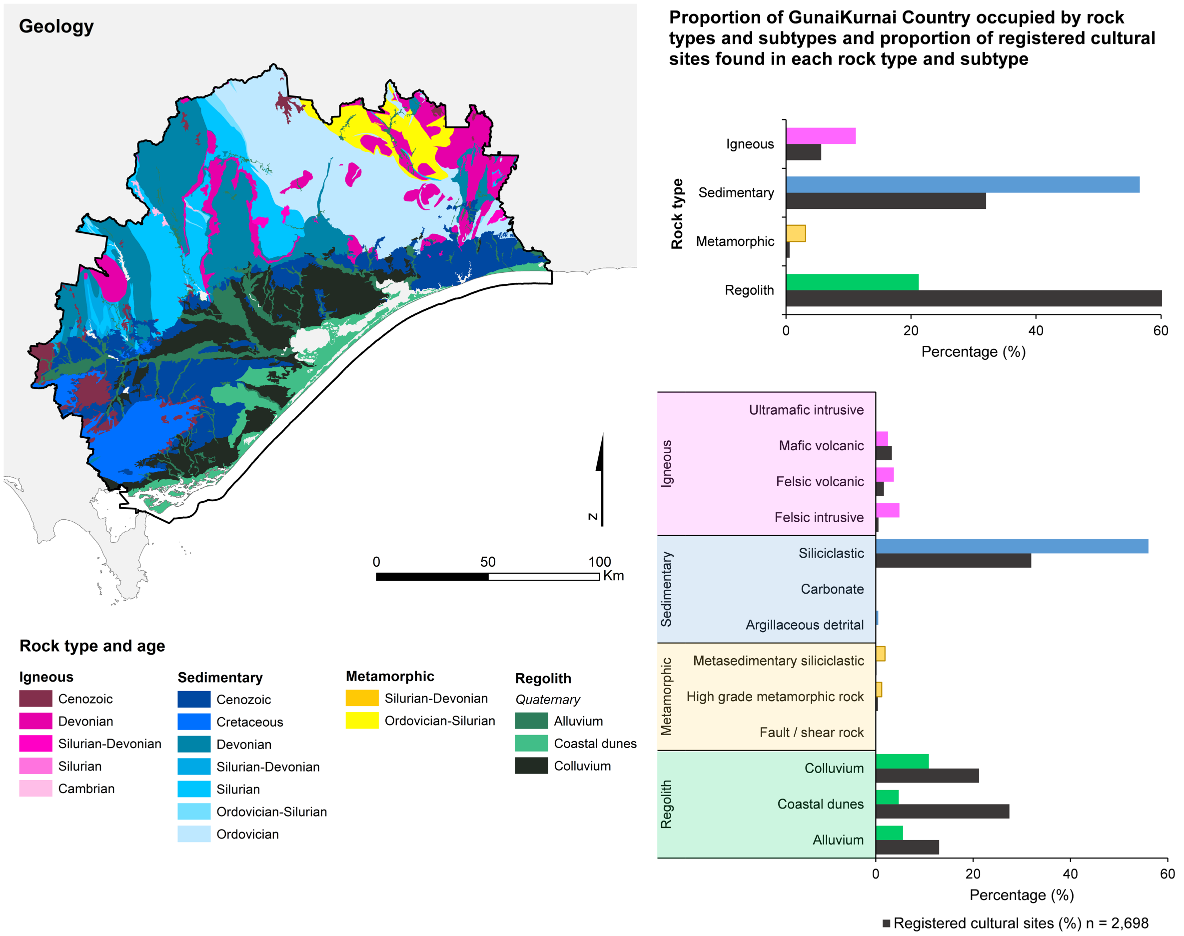

Figure 10.3. Map showing the surface geology of GunaiKurnai Country. The top-right graph shows the proportion of geological surface types for GunaiKurnai Country. The bottom-right graph shows the proportions of registered cultural sites by geological surface type. Data sourced from: Geoscience Australia (2012) Surface Geology of Australia, 1:1,000,000 scale, 2012 edition. Bioregional Assessment Source Dataset (http://data.bioregionalassessments.gov.au/dataset/8284767e-b5b1-4d8b-b8e6-b334fa972611).

10.5. Distribution of registered cultural sites by vegetation type

Across Australia there are 33 major vegetation types and 85 subgroups, as described by the National Vegetation Information System (NVIS: https://www.environment.gov.au/land/native-vegetation/national-vegetation-information-system). For visualisation and simplicity in this report, we have grouped these into eight categories, based on the similarities between the dominant tree species and type of vegetation. Note that we used the 85 vegetation subgroups for our groupings, as this gave the ability to separate the major vegetation type, “Eucalypt Forests”, into wet versus dry sclerophyll forests, which is important when exploring fire impacts and prevalence. We created the following eight categories:

1) Rainforest, which can include vine thickets, often has no dominant tree species, and where plant communities consist of dominant shrubs from one or more Antarctican (cool temperate) genus such as *Nothofagus*, *Podocarpus* and *Athrotaxis*.
2) Eucalypt Forest—dry sclerophyll forests (tall and open eucalypt forests often with a grassy or shrubby understory).
3) Eucalypt Forest—wet sclerophyll forests (tall, open, and often with a dense broad-leaved and/or fern understory).
4) Eucalypt Woodland (defined by areas where tree crowns are not touching, and trees are sparse).
5) Shrublands (dense thickets of vegetation with thick crown cover (mallee form *Eucalyptus* and *Acacia*) and/or dominated by shrub species such as *Melaleuca* and *Leptospermum*. Shrublands include heathlands, saltbushes and marshes and areas dominated by low, fine-leaved shrub species).
6) Grasslands (includes grasses that form distinct tussocks or hummocks, both perennial and annual, as well as some herblands, sedgelands and rushlands).
7) Other (other forests and woodlands, including those dominated by one of either *Acacia*, *Casuarina*, *Callitris*, *Melaleuca*, unclassified native vegetation, naturally bare, regrowth and other native vegetation and ‘unknown’).
8) Cleared (cleared vegetation, non-native vegetation, and buildings).

For this report, we have omitted all waterbodies, lakes, and rivers from our analysis, maps and plots, and used the vegetation spatial layer provided by the National Vegetation Information System (NVIS) for all mapping (https://www.awe.gov.au/agriculture-land/land/native-vegetation/national-vegetation-information-system/data-products#mvg60). Note that when comparing the numbers of registered cultural sites within each vegetation type, 108 of these fell under the category “water” on the GIS maps. These (e.g., sites just outside the coastline) were allocated the closest vegetation type. After doing this, there remained three registered cultural sites located in Lake Glenmaggie that were removed from the analysis, as they remained directly in the water (see Section 10.6 below, where we include water as a land-use category).

By far the most common vegetation type in GunaiKurnai Country are the Eucalypt Forests (50% of total area within the GKLaWAC RAP area). Of the Eucalypt Forests, 35% (9148 km^2) is wet sclerophyll, and 15% (3777 km^2) is dry sclerophyll. By contrast, the least widespread vegetation types are the Rainforests and Grasslands (each represents <1% of the GKLaWAC RAP area). Rainforest areas are scattered throughout the Eucalypt Forests (particularly in the southwest of the study area), and Grasslands among the cleared lands closer to the coastline in the south (Figure 10.4). Towards the north, contiguous areas of Eucalypt Woodland (total extent: 10% of the GKLaWAC RAP area) are interspersed among the Eucalypt Forest patch, while to the south along the coast near Lake Wellington, Shrublands predominate (Figure 10.4). Notably, much (just under 30%, 6917 km^2) of GunaiKurnai Country towards the southwest corner of the study region has been cleared for infrastructure such as roads, urban areas, and related developments ("Cleared", purple colour on Figure 10.4).

Even though the Eucalypt Forests are the most common vegetation type, this is not where most of the registered cultural sites are found. Rather, almost half (43%, n = 1157) of all the registered cultural sites in the GKLaWAC RAP area are found in the Cleared vegetation type, that is, in areas that once held native vegetation that have since been cleared for human infrastructure and use, including towns (Figure 10.4). Eucalypt Forests and Eucalypt Woodland contain equally the second-highest number of registered cultural sites (18–20%), despite the smaller area covered by Eucalypt Woodland (2658 km^2) than the much more widespread Eucalypt Forests (wet and dry sclerophyll = 12,925 km^2). Similarly, both wet and dry sclerophyll Eucalypt Forests contain similar numbers of registered cultural sites (10%), despite wet sclerophyll Eucalypt Forests covering almost triple the area of the dry (9148 km^2 vs 3777 km^2) (Figure 10.4). Shrublands contain 14% of the total number of registered cultural sites, which is high given its small area (715 km^2), with Rainforest having very few registered sites (n = 2, 0.07%).

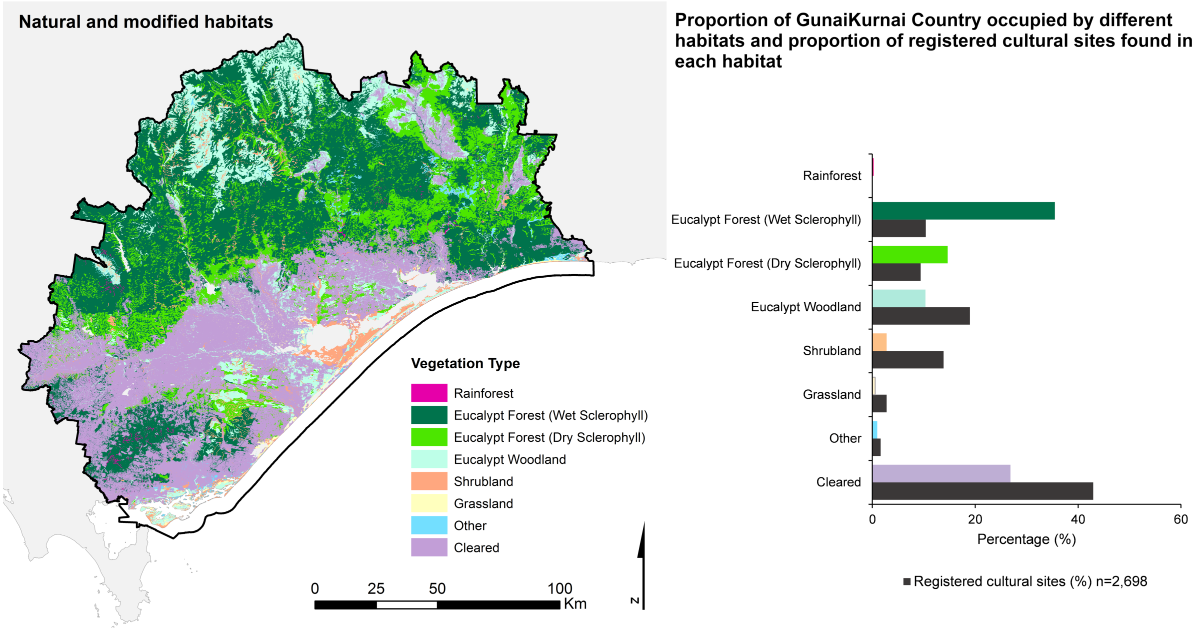

Figure 10.4. Left: Map showing the distribution of each of the seven broad vegetation types in GunaiKurnai Country. Right: Proportion of land covered by each vegetation type (colour-coded based on the left map and legend), and of registered cultural sites (dark grey bars), in GunaiKurnai Country. These data on vegetation types were sourced from the National Vegetation Information system (NVIS) database (https://www.environment.gov.au/land/native-vegetation/national-vegetation-information-system). The most recent year for these data were used (version 6, 2020), at a resolution of 100 × 100m.

10.6. Distribution of registered cultural sites by land use type

There are five primary types of land-use in Australia as defined by The Australian Land Use and Management Classification (ALUM; https://www.awe.gov.au/abares/aclump/land-use/alum-classification). Each type is distinguished in order of increasing levels of human development, management, intervention, and their impacts on the environment. The classes and some examples of each include:

1) Conservation and natural environments (nature reserves, wilderness areas, national parks, protected land and other minimal-use areas such as rehabilitation and residual native vegetation cover).
2) Production from relatively "natural" environments (grazing native vegetation, native forests used for the production of wood and other products).

3) Production from agriculture and plantations (including production from both dryland and irrigated systems; grazing modified pastures; hardwood and softwood plantations; horticulture; cropping and land in transition).
4) Intensive uses (intensive horticulture and agriculture, manufacturing and industrial, residential/urban, transport infrastructure, utilities, and mining).
5) Water/Other (water bodies, rivers, lakes, marsh or wetlands, estuary, or coastal waters).

For this report, as mentioned above we have omitted all waterbodies, lakes, and rivers from our analysis, maps and plots and used the land-use spatial layer provided by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES).

Using the four categories of land-use listed by The Australian Land Use and Management Classification (1–4 above), 75% of GunaiKurnai Country falls under some type of Production land or Intensive use (Categories 2–4), compared with only 20% that is under Conservation tenure or deemed to be “natural” environment (Category 1; Figure 10.5). The remaining 5% of GunaiKurnai Country is classified as “other” (including water bodies, rivers etc.; see Category 5 above). Of the land that is modified for human use in some way, Production from relatively “natural” environments makes up most of the GKLaWAC RAP area (37%), closely followed by Production from agriculture and plantations (33%) and Intensive uses (the highest category of human impact) (5%). In comparison, 66% of all registered cultural sites are found in the Production and Intensive use areas that covers 75% (19,322 km^2) of the total land area, with the other 34% found in the Conservation and “natural” environments that cover 20% (5075 km^2), a much smaller area of GunaiKurnai Country. Intensive use areas (6% of GKLaWAC Country) contain a high density of registered cultural sites (1 site/2.5 km^2), compared to areas of Production from relatively “natural” environments, which make up a large part of GKLaWAC Country with registered cultural site density at an average of 1 site/34 km^2). In other words, there is a greater likelihood that archaeological surveys have been undertaken and cultural sites have been found and registered where the land is more intensively used. This also shows that there are noticeably fewer registered cultural sites in land that is currently protected (917 sites), compared to in the total amount of land characterised as Production or Intensive use areas (1781 sites), where most people live and where infrastructure is most pronounced. Again, the pattern of registered sites reflects the greater intensity of archaeological surveys undertaken for Cultural Heritage Management in areas undergoing infrastructure construction such as through roadworks, earthworks and urban development. This pattern is of relevance to the impact of fires on cultural sites, because areas of denser human population, higher-density infrastructure and more managed vegetation cover are also the areas with greater fire management (and therefore fewer bushfires), more archaeological surveys and more registered cultural sites (also see Section 9, Figure 9.4 above). The areas more prone to bushfires have received less survey coverage for cultural sites, and will thus be under-represented by registered sites and knowledge of site distributions.

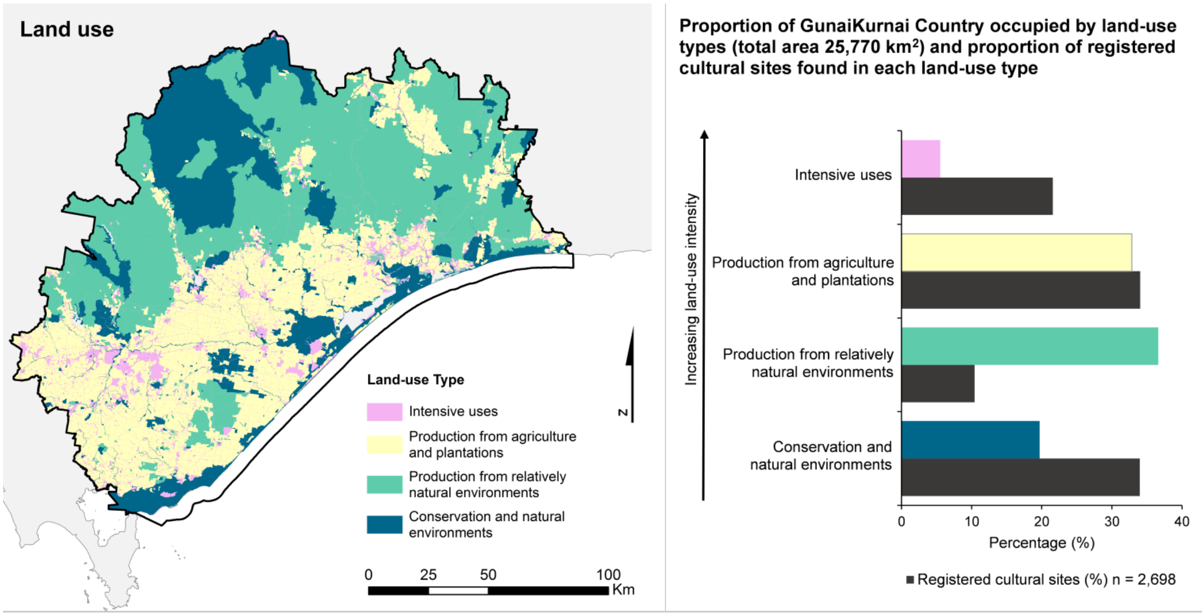

Figure 10.5. Left: Extent of each land-use type in GunaiKurnai Country. Right: Proportion of land in GunaiKurnai Country occupied by each land-use type (colours are based on the map and legend to the left) and proportion of cultural sites registered in each land-use type (dark grey bars). Land-use types are presented on the right, from bottom to top, in order of increasing land-use intensity. These data on land-use types were sourced from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES: https://www.awe.gov.au/abares/aclump/land-use/alum-classification).

11. The Impacts of Bushfires on Cultural Sites

By Bruno David, Jerome Mialanes, Joanna Fresløv, Jean-Jacques Delannoy, Jessie Buettel and Russell Mullett

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11.1. Impact of fires on rock shelters

Intense heating of rock shelters causes sections of the wall to fracture, and overhang collapse together with localised retreat of the wall are common results. This is called *thermal shock*. Convex wall surfaces near ground level are often shaped by thermal shock. Fires, either from camps, controlled burns of the landscape, or bushfires, cause curved sections of wall to detach, sometimes over distances measuring several metres. Rock variably conducts heat, and in so doing also variably resists heat and thermal shock. But it also tends to shatter when exposed to high temperatures, the depth of detachment representing the critical threshold between the heated rock outside and the non-heated matrix inside. Shattering takes place at the location of maximum heat, causing detachments that can be from a few centimetres to a few tens of centimetres thick, depending on the type of rock at stake. Where heating has been minimal, the detached rock tends to be thinner. The inner, conjoining face of a detached block is typically sub-parallel to what was previously the exposed face of the wall (now the dorsal face of the detached rock).

Thermal shock can affect a rock wall in a number of ways:

1. Laterally and vertically highly localised detachment scars, corresponding to locations of maximum heating.
2. The shape of a detached rock surface reflects more the surface shape of the original rock wall than the wall's rock layering, and in this differs from rockfall caused by gravity.
3. Detachment surfaces are curved and smooth, demarcating the boundary between the underlying unheated rock (the remaining, undetached part of the rock wall) and the overlying heated rock (the detached rock).

Thermal shock can be accentuated by brutal cooling, such as when a heated wall is rapidly cooled with water. Rocks shattered from thermal shock typically have sharp edges.

A different and more subtle type of rock breakage that also involves heat is *thermoclastic exfoliation*, caused by water and salts seeping through the rock matrix, compounding the expansion and contraction of rock surfaces through day–night temperature changes. This leads to the sub-centimetre deep exfoliation of rock surfaces. Exfoliated spalls are small, centimetre(s)-long, thin lenses of rock that retain on their dorsal surfaces the features of the original rock wall surface. A number of processes can cause exfoliation, such as the repeated expansion and contraction of micro-fractures (typically through day–night humidity and temperature fluctuations), or low-temperature thermal shock. Solar heating of the wall (thermoclastic exfoliation) only affects the outer surface of the rock.

Sometimes a rock shelter's fire-affected rock surface can increase the potential for that surface to be further damaged by thermoclastic exfoliation, such as where a fire has caused the rock surface to develop a red or dark patina. The darkened (e.g., reddened) surface covers a lighter parent rock, absorbing more heat than it reflects. Exfoliated spalls can detach at the level of contact between the outer surface heated by solar radiation, and the inner, non-heated rock. When this happens, the effects of exfoliation caused by solar radiation can be seen in the colour contrast between the underlying, unaltered and undarkened/unreddened rock exposed by the exfoliation scars and the thin, reddened rock skin above it (David et al. 2017: 417–418).

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11.2. Impact of fires on rock art and rock art sites

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11.3. Impact of fires on stone artefacts and stone artefact scatters

Stone artefacts are found in many places across GunaiKurnai Country. Some were **flaked** with a hammerstone (creating e.g., flakes, cores), some were **ground** by rubbing against another rock (e.g., ground-edge axes, grinding stones), and some were carried across the landscape and dropped on the ground without their shapes being modified by flaking or grinding (these are called '**manuports**', meaning 'carried by hand', after the Latin words '*manus*', hand and '*portare*', to carry). These terms are used in archaeological and cultural heritage management surveys all over the world.

Recognising when a stone has been made into an artefact is sometimes difficult, especially when its shape has changed through natural forces such as "insolation weathering" (from repeated daytime warming and night-time cooling) or bushfires. The information below shows how fire can change stone, and how to tell the difference between a rock that has been affected by fire versus one flaked by people.

Heat treatment

Stone is often unintentionally burnt by bushfires or campfires. Uncontrolled heating of stone is called '**heat alteration**'. However, people can also heat stone in controlled fires (or in heated sand beneath a fire) on purpose, to improve its flaking qualities. Such controlled heating of stone is called '**heat treatment**'.

Heat treatment is done by slowly heating stone and then slowly cooling it down. To get the best results, for most fine-grained, silica-rich raw materials such as cherts and flints, it takes between 7 hours and 2–3 days to reach the maximum temperature (which must be held for less than one hour) and to then slowly cool down the stone. But not all rocks benefit from heat treatment. This is the case for limestone, for example, because calcium carbonate, the major component of limestone, is poor at transferring heat and acts as an insulator. With quartz, heating makes it break into smaller pieces, but burnt quartz cannot easily be identified in the field because fluid inclusions >5 µm in diameter would need to be observed under >1000× magnification (Driscoll and Menuge 2011: 2259).

On the other hand, sedimentary silica-rich rocks such as chert, silcrete and quartzite benefit from heat-treatment. In fine-grained silica-rich rocks such as chert, heat closes the tiny spaces between the grains and heals defects within the stone. At a microstructural level, new bonds are created, improving how the rock is held together. The rock becomes more homogeneous, fracturing more predictably and requiring less force for flake detachment when tools are made.

The effects of bushfires on rocks and stone artefacts

The greater the intensity of a fire, the more it can damage stone artefacts. When heat is applied to stone in an uncontrolled way, it visually affects the stone in a number of ways. These are **colour change**, **crazing**, **potlids** and **potlid scars**, **deep surface cracking** and **heat fracturing**. Stone that has been burnt can also have residues stuck to it from the surrounding vegetation. These features appear at different stages of heat application (time under heat, maximum temperature reached, and speed of heating/cooling). Bushfires will usually cause greater damage to stone artefacts lying on the ground than when they are buried, as the flames affect the stone directly.

The larger the surface area of an artefact, the more damage it is likely to sustain from fire exposure, and the faster the damage will be. Smaller artefacts are less likely to be damaged.

Buried stone artefacts are generally protected from bushfires by soil cover and by partially combusted fuel. However, the longer a fire remains in one location, the higher the chance it will damage buried artefacts. Depending on soil conditions, temperatures up to 200 °C can be reached down to a depth of 10 cm (Aldeias et al. 2016). For archaeological sites where sediment has built up slowly, such depths would typically be hundreds or thousands of years old. Deeper and older artefacts will not usually be affected by bushfires, unless slow-burning tree roots or organic-rich peats burn below ground.

Colour change. Colour change can be one of the easiest ways to tell if stone has been heated, but only if there is good knowledge of the range of raw materials available in the area and their original colours. Knowing the original colour of raw materials is important, as the colour of an unheated raw material can be similar to that of a different heated one. When the original (unburnt) range of colours is not known, it can be difficult to tell through its colour if a stone has been burnt.

Each type of rock (e.g., basalt, quartzite, quartz, silcrete, chert, flint, etc.), and each source of a given type of rock, has its own distinctive chemistry, mineralogy and structure. This means that each can react to fire in slightly different ways. For instance, Fort Hood chert (a type of chert found in the USA) changes colour by the time it reaches 200 °C, whereas Pecos chert (another kind of American chert) does not show any signs of change until 900 °C is reached, at which stage minor colour changes occur. At that temperature, the Fort Hood chert will have crumbled to pieces (Table 1).

Not all stone contains iron and therefore some will not change colours when heated. In iron-rich stone, the iron content also dictates whether colour will change with heat, typically from yellow to red (Figure 4).

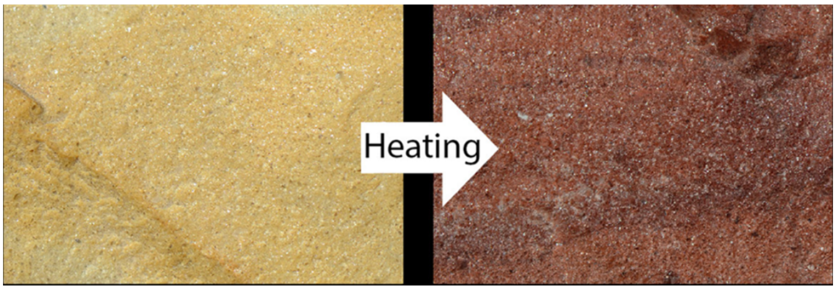


Figure 4. Colour change in silcrete (after Schmidt and Mackay 2016: 4).

Similarly, the chemical composition and minerals in limestone will determine whether its colour will change when heated. Some limestones change from a yellowish-beige colour to grey at 400 °C. Limestones containing iron oxides can turn to red when heated to 100 °C, getting redder until 300 °C, and then change from red to grey at 400 °C (González-Gómez et al. 2015:188).

Crazing. Crazing shows up as fine, twisted networks of thin and shallow surface cracks on rock surfaces (Figure 6).

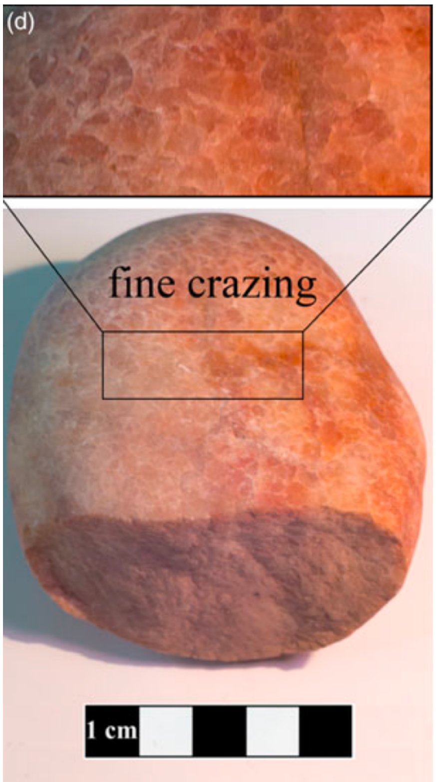


Figure 6. Crazing on quartzite cobble (after Neubauer 2018: 687).

Potlids and potlid scars. Potlids are a type of rounded (in plan view), flat-topped and half-domed (when seen from the side) pieces of stone that pop off the surface of a rock as a result of thermal fracturing (heating) (Figure 5). They are caused by “differential heating and pressure release probably due to steam buildup in areas of the material that has impurities or high moisture content” (Buenger 2003: 26). Potlids can range in diameter from less than 1 mm to more than 6 cm. The mark that is left on a rock after a potlid detaches is called a “potlid scar”. While potlids are technically not flakes, larger specimens can be used as tools or cores.

An absence of gloss coupled with the presence of potlid scars and crazing on a complete flake surface indicates fire damage *after* the artefact was made. The presence of potlid scars on the ventral surface of a flake that has no gloss or texture contrast is a sure sign of post-depositional heating (i.e., the heating of the stone has taken place after the flake was made, such as burning of an artefact by a bushfire). On limestone, potlids do not occur unless siliceous inclusions such as chert are present.

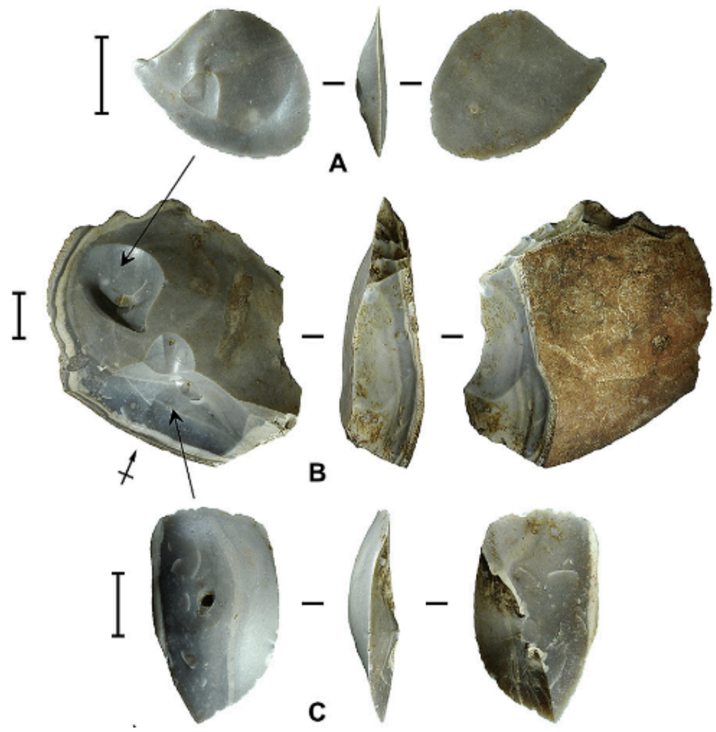


Figure 5. Potlids (A, C) and potlid scars (B) on chert artefacts (after Moore *et al*. 2009: 508).

Deep surface cracking and heat fracturing. Thermal shock from rapid temperature change damages a rock’s crystal structure. Surface cracks become progressively deeper with increasing cycles of thermal shock (Figure 7). These changes are accompanied by a loss of weight, increased porosity (air spaces in the rock) and an overall reduction in structural resistance (strength).

Figure 7. Deep surface cracks on flint artefacts following temperatures above 650 °C (after Fiers *et al*. 2021: 40).

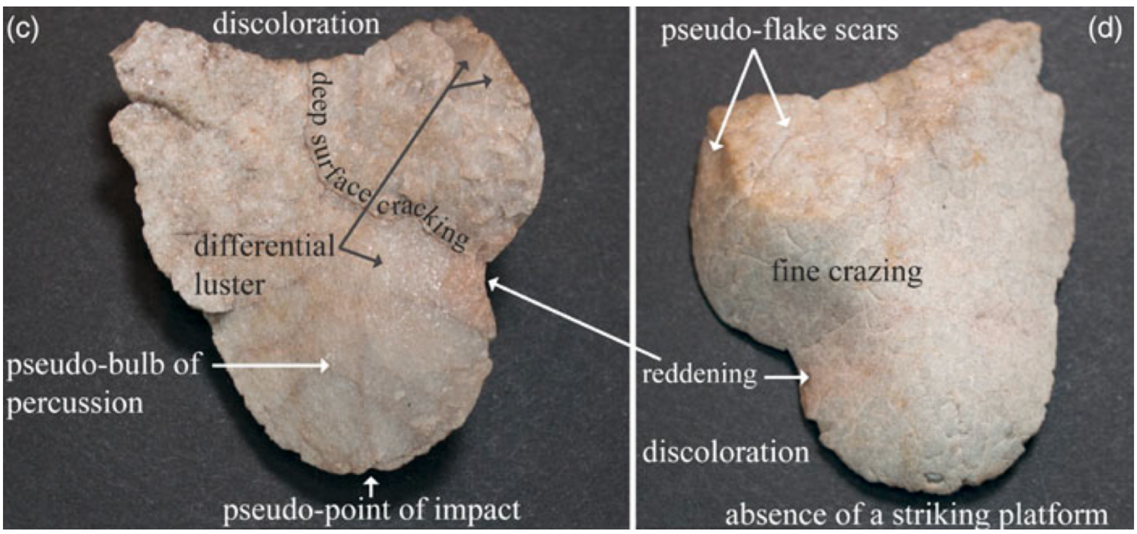


Figure 8. Heat-fractured rock missing a striking platform and that contains a location on its edge that resembles a point of force application (after Neubauer 2018: 685).

When uncontrolled heat fracturing occurs, such as in a bushfire, fractured rocks can sometimes look like stone artefacts. Several features can help confirm that it was caused by fire rather than by flaking (Figure 8). Heat-fractured rocks don't have striking platforms (this is an important missing feature that is also absent in rocks detached by exfoliation, when repeated changes in temperature cause the surface layer of rocks to detach in thin layers sometimes resembling flakes).

In frost-shattered rock, broken pieces can sometimes have flat surfaces similar to striking platforms, but they lack points of force application (the spot where a rock is hit to make a flake).

Although heat fracturing can happen in any kind of fire, people sometimes put rocks in controlled fires to break them through thermal shock, especially at quarries to break large rocks into more manageable size. Thermal shock would break rocks along existing lines of weakness within the rock. It would be difficult to differentiate blocks broken by the heat of bushfires from those purposefully broken by people using controlled fires (Florek 1989; Tibbett 2005).

Crenated fractures. Another characteristic of heat-fractured rocks is the presence of crenated (uneven or wavy) fractures (Figure 10).

Figure 10. Crenated fracture (after Purdy 1971:55).

Gloss. There are a number of ways to tell if a rock, or stone artefact, has been heated. The presence of differential lustre, or gloss contrast, on a rock can indicate that one part of the rock (the outside) broke before heating (the rougher surface), but another (e.g., a flake scar) was made after heating (the smoother, glossy surface) (Figure 11). The lustre or gloss is the way light reflects on the stone, creating an oily appearance.

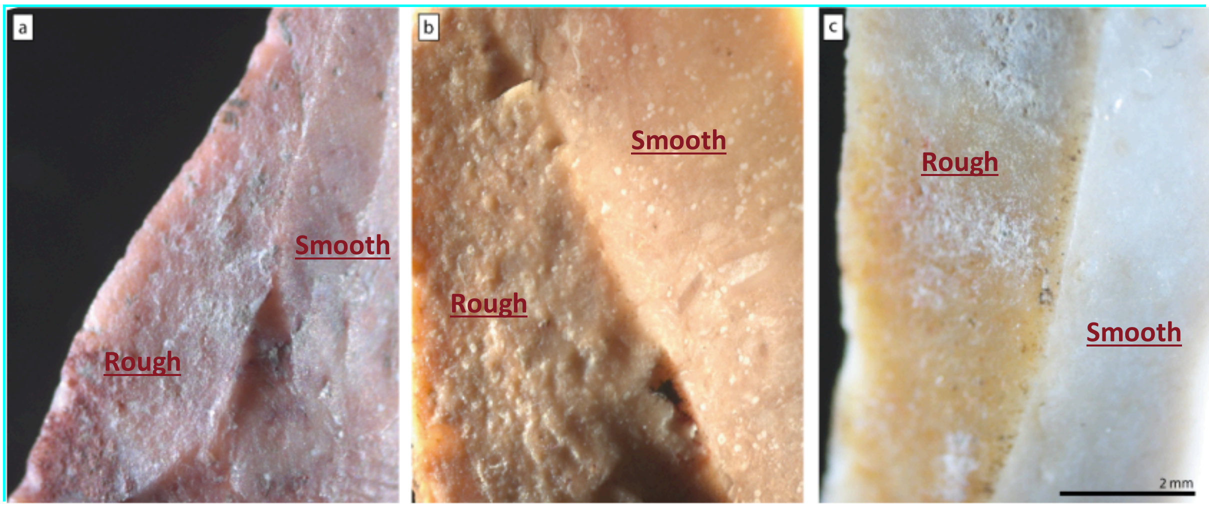


Figure 11. Close-up photos of gloss-contrast on three chert artefacts from Helga-Abri, a Mesolithic rock shelter in Germany. A–C: For each photo, Note the rough appearance of the flake scar on the left of the artefact compared to the adjacent flake scar on the right (after Schmidt *et al*. 2017: 24).

The glossiness of a rock surface is partially determined by how rough its surface is. On silcrete, gloss does not appear with controlled heat treatment, but a rock that was heated before being flaked will have its outer (pre-heating) surface relatively smooth, and its inner (post-heating) flake scar smooth (Figure 3). This contrast in gloss and/or texture cannot be achieved by any other means (e.g., bushfire or proximity to hearth, each of which affects the whole artefact). Identifying **heat treatment** is difficult, particularly when diagnostic features were removed from the heated artefact.

Limestone. Limestone is common in some parts of GunaiKurnai Country, especially near Buchan. Limestone, and rocks generally, can break naturally in three ways:

- **Thermal fatigue (e.g., insolation/onion-skin weathering**: This is a type of weathering common in warm areas. As the sun shines on a rock during the day, it causes it to expand. During the night, the rock contracts due to the colder temperature. This repetitive expansion/contraction causes the rock to break "along pre-existing lines of weakness, e.g. crystal boundaries" (Hall & Thorn 2014: 7) and for small pieces of surface rock to flake off.

- **Thermal shock**: This is "a single stress event whereby sudden (large) changes in temperature produce fracture because of the resulting stresses exceeding the capacity of the rock to adjust other than through instantaneous failure (Hall & Thorn 2014: 1). Limestone will break when subjected to rapid changes in temperature. Bushfires are the main cause of thermal shock, and rocks in campfires can also shatter through thermal shock.
- **Chemical weathering**: Water, which is slightly acidic, can slowly dissolve rock. Acidic rainwater changes the chemistry of limestone to form pavements. This occurs on the surface and along the joints and bedding planes of limestone.
- **Physical impact in high-energy environments**: In riverine and coastal environments, water-flow (surf, wave-action, currents, flooding) have sufficient power to shatter limestone.
- **Gravity**: Rock will break through gravity during mass-events such as landslides, earthquakes, colluvial erosion or roof-fall.

Key points on limestone being affected by bushfires (heat alteration):

- Not all limestones react similarly to heat, as their compositions are source-specific.
- While some limestones do not show changes when heated below 500 °C, those containing iron can display a change in colour (reddening).
- Some limestones can fracture at temperatures between 200–500 °C and disintegrate at temperatures above 600 °C.
- Limestones containing chert inclusions can also show evidence of potlidding when subjected to sudden and extreme changes in temperature (e.g., bushfire).

Table 1. Thermal effects on a range of stone raw materials.

Temperature (°C)	Fort Hood Chert (Buenger 2003)	Pecos Chert (Buenger 2003)	Quartz (Ryan 2010)	Quartzite (Moody 1976)	Silcrete (Mercieca and Hiscock 2008)	Limestone (Chakrabarti *et al*. 1995)	Ground stone (Ryan 2010)	Basalt (Ryan 2010)
100								No physical changes
200						Progressive reddening (if limestone contains iron)		
300	Colour change			Peak colour change from 250 °C followed by blotching till 450 °C				
400								
500	Potlid fractures, spalling			No physical changes			Smudging, organic materials present begin to diminish-pollen	
600	Extensive damage							
700	Fracturing + deterioration							Spalling, fracturing
800	Fracturing		Blackening, thermal expansion, crystalline structure change (>573 °C)		Cracks, Fracturing	Reduced strength, Disintegration if thermal shock	Organic material diminished-animal proteins	
900	Crumbling	Colour change						
1000								

Table 2. Dichotomous key for artefact and geofact identification (based on Niang 2014). By following the key from the start, stone artefacts versus stones with ventral-like surfaces broken by bushfires and other natural causes can be differentiated.

Key	Criteria	Go to
1	The point of force application is present	2
	The point of force application is absent	3
2	**It is probably a flaked artefact**	
3	The location of the point of force application can be identified	4
	The location of the point of force application cannot be identified	5
4	The exterior platform angle is less than 90°	6
	The exterior platform angle is more than 90°	5
5	**It is a geofact**	
6	There is a prominent bulb of percussion on the ventral surface	7
	There is no prominent bulb of percussion on the ventral surface	8
7	Flake scars are present on the dorsal surface	9
	Flake scars are absent from the dorsal surface	10
8	Ripple marks are present on the ventral surface	7
	Ripple marks are absent from the ventral surface	5
9	Dorsal flake scars are parallel to the medial axis	11
	Dorsal flake scars are not parallel to the medial axis	12
10	The striking platform is convex	5
	The striking platform is flat	2
11	Dorsal flake scars have similar patinas	2
	Dorsal flake scars have different patinas	5
12	The flake presents one or more retouched margins	2
	The flake does not present any retouched margins	13
13	Usewear is present on at least one margin	2
	Usewear is not present	5

11.4. Impact of fires on shell

…

11.5. Impact of fires on bone

…

11.6. Impact of fires on ochre sources

…

11.7. Impact of fires on scarred trees

…

11.8. Impact of fires on sub-surface archaeological deposits

…

12. Landscape Fires and Cultural Sites in GunaiKurnai Country

By Jessie Buettel, Stefania Ondei, Bruno David, Joanna Fresløv and Russell Mullett

Fire is a feature of Australian landscapes, but while many Australian vegetation communities have adapted to and evolved with its presence (e.g., *Eucalyptus* trees requiring fire to regenerate), the recent increase in the extent and severity of bushfires (see below), especially in fire-sensitive landscapes, has left devastation in its wake. With this increase in fire occurrence and area burned comes an increased risk of damage to irreplaceable cultural sites.

It is therefore important to consider how and why the impact of fire might be different across the landscape. Because cultural sites are distributed unequally across GunaiKurnai Country, it is likely that the impacts of fire will not be the same everywhere. Rather, those impacts will be dependent on the local-scale characteristics of the sites, such as vegetation type, land-use type, and the composition and structure of cultural sites and their artefacts.

While our focus is GKLaWAC Country, we sometimes address a slightly broader geographical area in this section, from the east coast to the south coast, central Victoria and the Australian Alps, to better take into account the nature and effects of bushfires across the land systems within and immediately surrounding GKLaWAC Country.

Unsurprisingly, and the land-use biases noted above notwithstanding, the number of registered cultural sites burnt corresponds strongly with the amount of area burnt through time, with the larger fires generally indicating a higher number of burnt cultural sites. Since 1930, a total of 970 cultural sites have been burnt at minimum once, irrespective of fire type (Table 12.1). Over 32% (n = 870) of all registered cultural sites (n = 2698) have been burnt by bushfires at least once, with 11% (n = 298) burnt once by prescribed burning (Table 12.1). Note that this does not reflect whether sites have been burnt more than once during this time.

Table 12.1. Number of registered cultural sites burnt by bushfires and prescribed burns since 1930 in GunaiKurnai Country. Note that each site is represented only once in this table, though we know that some sites were burnt by either fire type more than once. The total number of registered cultural sites burnt (far right column) is not the sum of the

number burnt by bushfire plus prescribed burning, as the same site could have been burnt by both fire types over time.

Site Type	Total number of sites	Number burnt by bushfire	Number burnt by prescribed burning	Total number of sites burnt
Aboriginal Ancestral Remains (Burial)	10	1	0	1
Aboriginal Ancestral Remains (Burial) & Aboriginal Historical Place	1	0	0	0
Aboriginal Ancestral Remains (Burial) & Artefact Scatter	6	0	0	0
Aboriginal Ancestral Remains (Burial) & Artefact Scatter & Shell Midden	4	0	2	2
Aboriginal Ancestral Remains (Burial) & Shell Midden	1	0	0	0
Aboriginal Ancestral Remains (Reinterment)	1	0	0	0
Aboriginal Cultural Place	1	0	0	0
Aboriginal Historical Place	13	5	1	5
Aboriginal Historical Place & Artefact Scatter	1	0	0	0
Artefact Scatter	1645	712	207	756
Artefact Scatter & Earth Oven	1	1	0	1
Artefact Scatter & Grinding Grooves	2	0	0	0
Artefact Scatter & Hearth	4	0	0	0
Artefact Scatter & Hearth & Shell Midden	1	0	0	0
Artefact Scatter & Hearth & Subsurface	1	0	0	0
Artefact Scatter & Quarry	3	3	1	3
Artefact Scatter & Rock Art	1	1	0	1
Artefact Scatter & Rock Art & Subsurface	2	2	1	2
Artefact Scatter & Shell Midden	145	4	25	28
Artefact Scatter & Shell Midden & Subsurface	2	0	0	0
Artefact Scatter & Subsurface	37	10	0	10
Bora Rings	1	0	0	0
Grinding Grooves	20	0	0	0
Grinding Grooves & Quarry	1	0	0	0
Low Density Artefact Deposit	18	0	5	5
Low Density Artefact Distribution	145	39	14	42
Mound	1	1	0	1
Object Collection	34	2	4	4
Quarry	10	10	1	10
Scarred Tree	387	74	24	81
Shell Midden	195	4	13	17
Shell Midden & Subsurface	4	1	0	1
Total sites	**2698**	**870**	**298**	**970**

When looking at how the number of registered cultural sites burnt by bushfires changes through time, the number decreases from 743 now-registered sites burnt between 1930–1999 (i.e. at an average rate of 11 registered sites/year), to 472 between 2000–2020 (24 registered sites/year), matching the greater area of land burnt in the 20th century but the greater rate of burning in the 21st (Figure 12.1 and Figure 9.1 above).

In contrast, the number of registered cultural sites burnt by prescribed burning is remarkably similar over the two periods (1930–1999: 70 years, n = 186 cultural sites; 2000–2020: 20 years, n = 165 cultural sites), despite the greater extent of area burnt by prescribed fires between 1930–1999 (6721 vs 3638 km^2) (Figure 9.1, Chapter 9 above). However, even though slightly more registered cultural sites were burnt by prescribed burns between 1930–1999, on average three registered cultural sites were burnt per year (minimum = 0; maximum = 33) during those 70 years, compared with an average of eight burnt per year in the 20 years between 2000–2020 (minimum = 0; maximum = 456). In other words, in the past 20 years cultural sites burnt at a rate of 2.5-times as fast as in the previous 70 years of prescribed burning. In the past two decades, the years that had particularly high numbers of registered cultural sites burnt by prescribed burning include: 2004 (33 sites), 2005 (27 sites), 2012 (25 sites), 2013 (19 sites), and 2019 (13 sites).

Each year since 1980 has seen at least one registered cultural site burnt by prescribed fires, with the exception of 1986 and 2020. Interestingly, the large-scale bushfire events in the years 2007 and 2019 had no impact on the number of cultural sites burnt by prescribed burning, as each decade saw 86 and 98 cultural sites burnt, respectively (Figure 12.2). In other words, the big bush fires in the two most recent decades did not change how much was prescribed-burned per decade, and therefore the number of burnt registered cultural sites consistently remained close to 100 for the last four decades (1980–2000s). It is also possible that prescribed burns were largely undertaken in the same locations each decade.

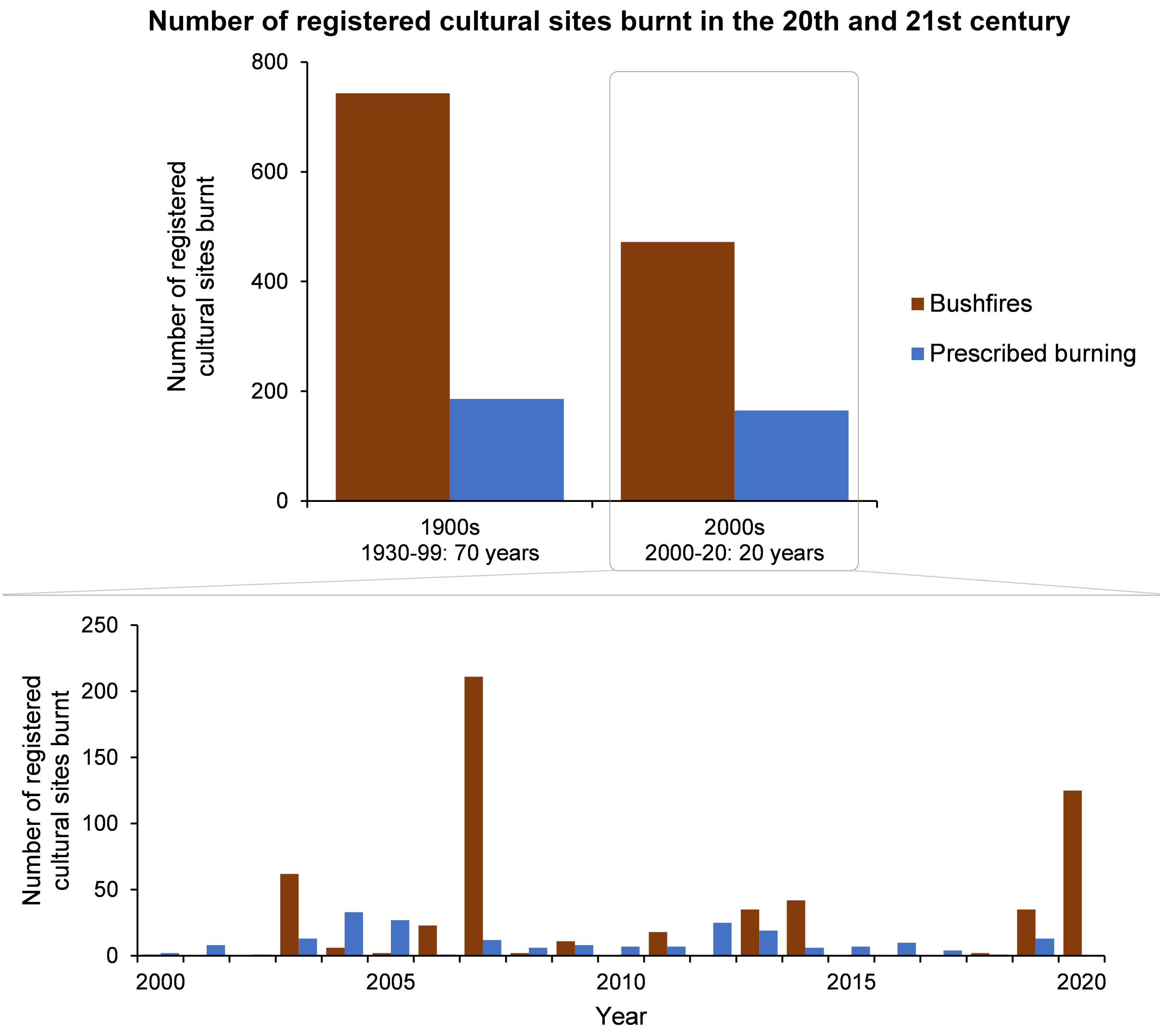


Figure 12.1. Number of registered cultural sites burnt by bushfires (brown bars) and prescribed burns (blue bars) between 1930–1999 vs 2000–2020. The lower graph shows the number of registered cultural sites burnt each year by bushfires and prescribed burns since 2000. Note that registered cultural sites are only counted once, even if they have been burnt by either fire type multiple times within each time period.

However, the greater number of registered cultural sites burnt by bushfires between 1930–1999 is largely a result of the two large-scale bushfire events of the 1930s and 1960s (Figure 12.2). These bushfires were massive in extent, in particular the Black Friday fires that remain unmatched in extent and severity across the fire history record to date (see Chapter 9, Figures 9.1 and 9.2 above). Indeed, the years that experienced these large-extent bushfire events contribute significantly to the numbers of registered cultural sites that burned in each decade (Figure 12.2).

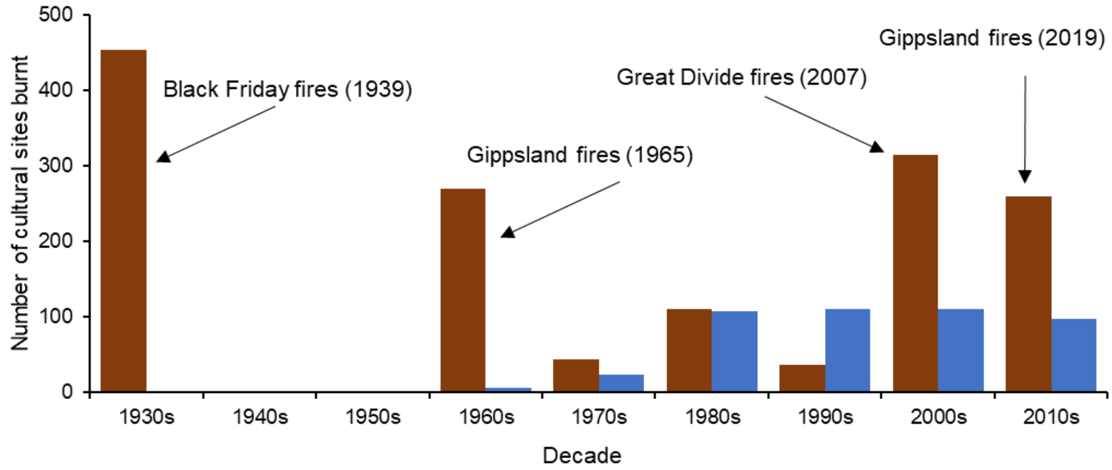


Figure 12.2. Number of registered cultural sites burnt by bushfires (brown bars) and prescribed burns (blue bars) across each decade in GunaiKurnai Country. The four largest fire events are indicated by arrows to their corresponding decades, with the year they occurred in brackets.

The four largest bushfire events each burnt on average 237 registered cultural sites (minimum = 125, maximum = 456; Table 12.2). By a long shot, the Black Friday fires were the most extensive, burning 456 registered cultural sites, followed by the Great Divide fires of 2007, which burnt 211 registered sites, followed by the Gippsland fires of 2019–2020 with 165 registered sites, and the Gippsland fires of 1965 with 154 registered sites (Table 12.2). Surface Artefact Scatters have been burnt in high numbers during each of the large bushfire events, primarily because they are the more numerous and widespread of the cultural sites (Table 12.2).

Table 12.2. Number of registered cultural sites that were burned by the four major bushfire events: Black Friday fires (1939), Gippsland fires (1965), Great Divide fires (2007) and Gippsland fires (2019–2020).

Site type	**Black Friday fires (1939)**	**Gippsland fires (1965)**	**Great Divide fires (2007)**	**Gippsland fires (2019–2020)**
Aboriginal Ancestral Remains (Burial)		1		

Aboriginal Historical Place	1		2	1
Artefact Scatter	416	106	194	136
Artefact Scatter & Earth Oven	1			
Artefact Scatter & Quarry	2		1	1
Artefact Scatter & Rock Art		1		
Artefact Scatter & Subsurface	5	2		2
Artefact Scatter & Subsurface & Rock Art				2
Low Density Artefact Distribution	10	15	3	11
Mound	1		1	
Object Collection				1
Quarry	6		1	6
Scarred Tree	14	29	9	4
Shell Midden				1
Total	**456**	**154**	**211**	**165**

Some bushfires and prescribed burning events can occur in the same location(s) year to year. This means that some cultural sites may be burnt more than once in a given year, decade, or century. The more times a cultural site is burnt, the greater the likelihood of incremental damage or loss of both artefacts and sites. Indeed, of the 870 registered cultural sites that were burnt by bushfires since 1930 (Table 12.1), 56% (n = 490) of these burnt once, 21% (n = 182) twice, 18% (n = 157) three times, 4% (n = 34) four times and 1% (n = 7) five times. Of the seven registered cultural sites that were reported to have been burnt by bushfires five times, since 1930, six are of the site type Artefact Scatter, and one is an Artefact scatter & Quarry (Table 12.3). One registered cultural site (Artefact Scatter) was burnt by prescribed burning five times.

Across all registered cultural sites, Artefact Scatters are the site type most often burnt more than once by bushfires, with 371 sites burnt once, and a total of 380 burnt twice or more (Table 12.3). They are also the most represented site type burnt more than once by prescribed burning, with 117 registered Artefact Scatters burnt once, and 106 burnt twice or more. Scarred trees are the next most frequent cultural site burnt by both bushfires and prescribed burning events, followed by Low Density Artefact Distribution and Artefact Scatter & Shell Midden (Table 12.3). Of interest, Artefact Scatter & Shell Midden and Shell Midden sites were burnt more often by prescribed burning than bushfires, probably due to their high numbers along the coast including in and near highly frequented public Parks and

Reserves where fire management is heightened. There were also two Aboriginal Ancestral Remains (Burial) & Artefact Scatter & Shell Midden sites burnt once by prescribed burning but not bushfires (Table 12.3).

Table 12.3. Numbers of registered cultural sites that were burned by bushfires and prescribed burning, and the number of times they were burnt. Each site is represented only once within each fire type, with some sites burnt by bushfires also possibly having been burnt by prescribed burning.

Site type	**Number of times burnt**									
	Bushfires					**Prescribed burning**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Aboriginal Ancestral Remains (Burial)	1									
Aboriginal Ancestral Remains (Burial) & Artefact Scatter & Shell Midden						2				
Aboriginal Historical Place	3	2				1				
Artefact Scatter	371	148	154	33	6	117	53	29	7	1
Artefact Scatter & Earth Oven	1									
Artefact Scatter & Quarry		1	1	1	1			1		
Artefact Scatter & Rock Art	1									
Artefact Scatter & Rock Art & Subsurface	2					1				
Artefact Scatter & Shell Midden	4					24	1			
Artefact Scatter & Subsurface	6	4								
Low Density Artefact Deposit						5				
Low Density Artefact Distribution	31	8				9	4		1	
Mound		1								
Object Collection	1		1			2		2		
Quarry	5	4				1				
Scarred Tree	59	14	1			17	6	1		
Shell Midden	4					13				
Shell Midden & Subsurface	1									
Total	**490**	**182**	**157**	**34**	**7**	**192**	**64**	**33**	**8**	**1**

13. Archaeological Surveys in GKLaWAC Country

By Robert Skelly, Bruno David, Joanna Fresløv and Russell Mullett

A number of archaeological surveys have been undertaken following major bushfires in GKLaWAC Country. These surveys have aimed to document the characteristics and distribution of archaeological sites in the fire-affected areas, and to make recommendations for their improved protection from the impacts of fires. Following the Caledonia Area bushfire in the Southern Alpine Region from December 1997–January 1998, David *et al*. (1998) assessed the impacts of heat from the fires and fire-suppression methods on Aboriginal sites. A sample of the burnt area was surveyed, with a focus on waterways, ridgelines and saddles which were assessed as likely places for Aboriginal land use and settlement. David *et al*. (1998) found that the fire improved the effectiveness of site identification without biasing an assessment of site distribution. The study found that radiant heat in high-intensity burn areas had detrimental impacts on surface stone artefacts, with one-third of the stone artefacts identified showing some form of fire damage.

Following bushfires in the Gippsland Southern Alpine Region in 2002–2003, Aboriginal Affairs Victoria (AAV) conducted a targeted investigation of the effects of the fires on cultural heritage sites at Dinner Plain, Mount Hotham, Omeo, Orbost, Gelantipy, Suggan Buggan and Limestone Creek (Aboriginal Affairs Victoria 2003). The field surveys focussed on areas disturbed by mechanical fire-suppression activities, and 50 Aboriginal sites were identified. Mechanical fire-suppression was found to have damaged many Aboriginal sites, with some being completely destroyed. A key finding from the report was that fire-control lines are likely to be positioned on culturally sensitive landforms, and, as a consequence, that fire-control lines have had disproportionately high impacts on the integrity of Aboriginal sites, often critically damaging or totally destroying sites (Aboriginal Affairs Victoria 2003: 5).

In 2003, Parks Victoria (PV) and the Department of Sustainability and Environment (DSE) commissioned a post-bushfire cultural heritage investigation of the Gippsland Northern Alpine Region (Kelly 2003). These surveys differed from those undertaken in the Southern Alps by Aboriginal Affairs Victoria (2003), in that culturally sensitive landforms were targeted rather than areas disturbed by mechanical fire-suppression. Twelve Aboriginal sites were identified during the surveys. The study concluded that heat from low-intensity burns had minimal impacts on stone artefacts (discolouration), whereas high-intensity burns increased the brittleness of artefacts and left them susceptible to secondary fracturing. Where Aboriginal sites were located in areas impacted by mechanical fire-suppression, damage to sites was severe.

Following the 2002–2003 fires, government agencies established the Public Land Ecological and Cultural Bushfire Recovery Program to assist environmental, community and infrastructure recovery. The program was jointly managed by Parks Victoria and the Department of Sustainability and Environment, and recognised that a greater understanding of how fire management impacted Aboriginal cultural heritage was needed, so that management practices could be improved. Heritage Solutions Pty Ltd were commissioned to investigate 14 fire-affected areas (Fresløv 2004). The project brief asked the investigators to:

1. Assess and document the nature and extent of damage caused by bushfires and associated fire-suppression activities to Aboriginal cultural heritage sites across the project area, and to provide recommendations for site protection and future management.
2. Work with the Aboriginal community in documenting matters such as cultural significance and traditional interpretations of recorded sites, and in developing appropriate management options.

The resulting Post Wildfire Indigenous Heritage Survey (Fresløv 2004) provides a comprehensive appraisal of Aboriginal cultural heritage values in the fire-affected areas, along with an assessment of how radiant heat and fire-suppression activities impacted those sites. The assessment included fire impacts on stone artefact scatters, scarred trees and rock shelters, as well as on oral history ("intangible" or "story place") Aboriginal heritage sites and values.

Fresløv (2004) divided fire impacts into short-term and long-term impacts. Radiant heat generated by fires and fire-suppression activities were deemed short-term impacts, with post-fire erosion and ground-disturbing rehabilitation works long-term impacts. In agreement with Kelly (2003), Fresløv found that low-intensity fires had minimal or no impacts on surface stone artefacts, whereas high-intensity fires caused considerable damage such as potlidding (see below) and increased brittleness on stone artefacts. For sub-surface cultural materials, Fresløv (2004) observed that sediments provided insulation from radiant heat, so that subsurface materials remained largely unaffected by the fires regardless of heat-intensity.

Impacts to cultural heritage values caused by fire-suppression activities and rehabilitation works, including mechanical clearing, chainsaw tree-felling, heavy-vehicle traffic, access works, track construction and road-widening, were also investigated (Fresløv 2004). The investigation found that heavy-vehicle traffic and the construction of mineral earth containment lines damaged surface sites by fragmenting and dispersing artefacts. Of great concern, it also found that sub-surface sites unaffected by radiant heat were being damaged or destroyed by mechanical fire-suppression activities.

The major problem identified by Fresløv (2004) is that Aboriginal archaeological sites are a finite resource, and that once cultural sites have been compromised or damaged by physical impacts, then their integrity can never again be restored. The essential message for the future management of GunaiKurnai sites in fire-affected areas is that each site is part of a GunaiKurnai cultural landscape that encapsulates ancestral knowledge, contemporary Aboriginal culture, and information on cultural history. From a management perspective, damage caused to a particular site is not limited to that individual locality, for all impacts to cultural sites cause irreversible, incremental damage to the broader GunaiKurnai cultural landscape and to Aboriginal culture.

In addition, GunaiKurnai sites are also irreplaceable sources of information on GunaiKurnai history—as noted above, the sites are GunaiKurnai history books written in the landscape—and that information is permanently lost when the spatial and/or stratigraphic integrity of a site is disturbed.

During the course of Fresløv's Post Wildfire Indigenous Heritage Survey, 319 Aboriginal sites were identified. Most were stone artefact scatters (76%) located in high-intensity burn areas, where ground-surface visibility was correspondingly high. The construction of fire-control lines damaged 43 sites (13%), and access tracks damaged a further 57 sites (17%). To avoid damage to GunaiKurnai cultural heritage during future fire events, Fresløv (2004) advocated the adoption of a set of Cultural Heritage Management Principles. These Management Principles addressed three fire-event phases: 1) fire preparedness; 2) fire-suppression; and 3) fire recovery. The key aim of the Management Principles was to identify means of avoiding damage to Aboriginal cultural heritage during future fire events. A critical factor advocated to achieve the key management aim was the maintenance of a consultation process with Aboriginal communities during each of the three fire management phases.

The Timbarra Fire Complex bushfire (Timbarra, Sunny Point and Buchan South) started on 23 September 2017 and burnt 8963 hectares. The response to the fire provides an insight into how Fresløv's (2004) Management Principles were applied 13 years after they were first recommended. As part of the fire recovery strategy, the Department of Environment, Land, Water and Planning (DELWP) and Parks Victoria arranged a rapid six-day assessment by the Bushfire (Rural and Regional Affairs and Transport) team in 2017. Team deployment was initiated by the DELWP Incident Management Team on behalf of the State of Victoria. The purpose of the deployment was to prepare a report for land managers with a "snapshot" of the priority risks posed by the fire event.

The Bushfire RRAT Report (Department of Primary Industries and Parks Victoria 2017) acknowledges Traditional Owners as one of the land management agencies, and identifies potential damage to "Aboriginal heritage and loss of cultural sites and artefacts" as one of the top priority risks to be addressed. The report also acknowledges GKLaWAC as the Registered Aboriginal Party (RAP) for the fire-affected area and alerts to reputational risks that could be caused if GKLaWAC were not provided with an opportunity to be involved in fire management. The report identifies potential risks to unknown Aboriginal sites inside fire-impacted areas, recommending:

1. That engagement of stakeholders during rehabilitation and recovery represents a valuable opportunity for land management agencies to strengthen important relationships as well as improving knowledge and understanding of heritage values, and to ensure their effective protection and preservation. Of primary importance is to maintain an open dialogue and ensure continual engagement and involvement in recovery activities.
2. That a cultural heritage evaluation of disturbed areas within the fire-affected area is undertaken with the Traditional Owners to locate, record and interpret Aboriginal sites that may have been revealed through the reduction of vegetation cover or exposed because of fire-suppression activities. It is important to note here that once a fire emergency is downgraded from a Level 3 incident, the *Aboriginal Heritage Act* 2006 comes into effect again; activities performed during rehabilitation and recovery phases may damage unharmed, or further damage partially harmed, sites.

The report's recommendations align well with the Management Principles advocated by Fresløv in 2004. However, it makes no reference to consultation having occurred with Traditional Owners. The report states that information regarding cultural heritage was sought from Aboriginal Affairs Victoria (now Aboriginal Victoria), but there is no specific record of consultation with GKLaWAC at any stage within the report.

This apparent lack of consultation is highly problematic, particularly given that the report acknowledges that there had been no comprehensive Aboriginal cultural heritage surveys of the fire area and that unknown Aboriginal sites may be present. Instead of consultation, the report relies on a desktop study citing ACHRIS, Aboriginal Victoria's Aboriginal sites register, which led to the conclusion that "sites of Aboriginal heritage are known to be within the landscape but outside the fire area" (Department of Primary Industries and Parks Victoria 2017: 41). This limited reference to, and recognition of, Aboriginal heritage *outside* the fire area suggests that it is time for Fresløv's (2004) Management Principles to be re-addressed, to ensure that appropriate consultation and actions are taken to properly address the unregistered sites, which form the vast majority of Aboriginal sites across Victoria, GunaiKurnai Country included. In addition, future reporting should take due care to correctly cite agency sources (AV rather than AAV) and respond to appropriate legal responsibilities and obligations. The report cites legislation, regulations and codes of practice including the *Heritage Places Act* 1993 which applies to cultural heritage management practices in South Australia. Future surveys and reporting should respond to, and consider, legal responsibilities and obligations as required under the *Aboriginal Heritage Act* 2006 and the *Aboriginal Heritage Regulations* 2018.

In July and August 2019, Skelly *et al*. (2019) surveyed 64 linear kilometres of fire-affected areas on foot, and 1116 km by slow-moving vehicle, following the Nunnett-Timbarra Rivers and Holey Plains bushfires that burnt 32,681 hectares of GKLaWAC Country. The cultural heritage field surveys targeted areas impacted by high-intensity fires and landscapes with high cultural heritage sensitivity. Particular attention was given to areas where ground-disturbing mechanical fire-suppression and clean-up activities had been employed during and shortly after the fires, to determine how such activities may have impacted Aboriginal sites.

The surveys resulted in the identification and documentation of 99 Aboriginal sites (Holey Plains State Park area = 20 sites, Nunnett-Timbarra River area = 79 sites). Of these, 73 sites had been disturbed or destroyed. The construction of access roads and tracks was the main cause of disturbance, impacting 59 (60%) of the identified sites. Forty-eight (48%) of the sites had been disturbed by fire-suppression activities. These activities included heavy-vehicle traffic, road-widening, the construction of earthworks, and the cutting of containment lines.

Impacts to Aboriginal sites in the Nunnett-Timbarra River area were amplified by the placement of roads, tracks and containment lines on low-gradient ridgelines and spurs that are precisely the topographic features identified by GKLaWAC RAP crews as pathways followed by GunaiKurnai ancestors as they moved across the landscape. In addition, heavy-vehicle disturbance exposed artefacts formerly hidden beneath shallow layers of sediment, revealing and further heightening the presence of Aboriginal sites now in disturbed contexts. These survey findings are consistent with Fresløv (2004: 22), who had previously concluded that fire-related damage to Aboriginal sites was most likely to occur "where control lines are placed on flat areas where flat land is at a premium on flatter ridgelines, river flats, terraces, gentle spurs above rivers".

Legal responsibilities and obligations for the protection of Aboriginal cultural heritage are legislated under the *Aboriginal Heritage Act* 2006 and the *Aboriginal Heritage Regulations* 2018 which give effect to the Act. In the event of emergencies such as in the case of bushfires, the *Emergency Management Act* 2013 takes over. That Act defines an emergency as the "actual or imminent occurrence of an event which in any way endangers or threatens to endanger the safety or health of any person in Victoria or which destroys or damages, or threatens to destroy or damage, any property in Victoria or endangers or threatens to endanger the environment or an element of the environment in Victoria". The *Emergency Management Act* 2013 overrides the requirements of the *Aboriginal Heritage Act* 2006.

In relation to Aboriginal heritage management in the event of a bushfire, Aboriginal Victoria Technical Specialists and DELWP Values Officers in the Planning Section of the Incident Control Centre provide advice to the Incident Controller. This advice provides options for managing Aboriginal cultural heritage. It is important to note for such emergency planning, that when the Aboriginal Cultural Heritage Register and Information System (ACHRIS) managed by Aboriginal Victoria shows a landscape without any registered Aboriginal Places, that absence of registered Aboriginal Places does not necessarily mean their absence in that landscape. Rather, it usually simply means that none are known and registered (because appropriate cultural heritage surveys have not yet been undertaken to generate the necessary data). Skelly *et al*. emphasised that, consistent with international standards and legislation for the protection of Indigenous cultural heritage, the "any property" that the *Emergency Management Act* 2013 specifically aims to protect should include cultural heritage (Aboriginal) sites such as those identified in this report.

Fresløv's (2004: 28–30) previously developed set of management principles based on cultural heritage surveys following bushfires impacting large parts of East Gippsland in 2003 (see above for details) are as relevant today as when first formulated:

1. *Fire prevention planning and preparedness*. Planning should take place in collaboration with Aboriginal Traditional Owners to facilitate the protection of Aboriginal cultural heritage sites. This approach should re-affirm the principles of the state-wide Code of Practice for fire management on public land, improve consultation and communication with Aboriginal communities and increase awareness of Aboriginal cultural heritage values among fire managers and fire-suppression personnel, thus providing the highest possible protection for Aboriginal cultural heritage sites during fire-suppression activities.
2. *Fire-suppression*. During any fire event, Aboriginal cultural heritage sites should be protected and managed in a cooperative, strategic and sensitive way in consultation with affected Aboriginal communities.
3. *Fire rehabilitation and recovery*. Following fire events, impacts to Aboriginal cultural heritage sites should be identified through community consultation and cultural heritage surveys in fire-affected areas. Fire rehabilitation and recovery plans should be developed in collaboration with Aboriginal communities to minimise impacts to Aboriginal heritage sites. Landscape rehabilitation following a fire event can itself damage or destroy cultural heritage sites. Therefore, prior to landscape rehabilitation, the fire rehabilitation and recovery plan needs to incorporate an Aboriginal site management plan.

Key to the success of proposed activities and actions is ongoing consultation with the local Aboriginal communities during fire prevention, fire-suppression and fire recovery.

14. Understanding the Distribution and Impacts of Bushfires in GunaiKurnai Country through Sub-bioregions

By Jessie Buettel, Stefania Ondei, Bruno David, Joanna Fresløv and Russell Mullett

GunaiKurnai Country contains a wide range of environmental zones. Differentiating the study region by environmental zone or "bioregion" allows for a more detailed understanding of the spread of bushfires, the distribution of cultural sites, and for how to make better predictions on the actual and likely impacts of fires on cultural sites across the landscape. While a fire may begin in one bioregion, it may (or may not) spread to another: understanding the spread of fires within and across bioregions, each with its own fuel loads and distribution of cultural sites, may shed useful light on management needs or options at a landscape scale.

Here we have used the national *Interim Biogeographic Regionalisation of Australia* (IBRA) bioregion framework to sub-divide GKLaWAC and nearby areas into analytical landscape units. There are 89 major bioregions across Australia. These can be sub-divided into 419 smaller sub-bioregions that consist of more localised (local-scale) geomorphological units within the bioregions. Each of these bioregions and sub-bioregions is environmentally and climatically distinct, and grouped according to common climate, geology, landform, native vegetation, and species information. For this report, we are interested in the IBRA sub-bioregions that intersect with or are in proximity to GunaiKurnai Country. There are 11 sub-bioregions that fit this criterion (Table 14.1, Figure 14.1).

Table 14.1. The IBRA sub-bioregions (Australia's bioregions (IBRA)—The National Reserve System (NRS) | Department of Agriculture, Water and the Environment) that intersect and sometimes border GunaiKurnai Country. Shown is the broader bioregion each sub-bioregion is within, the total area of each sub-bioregion (in km^2) and the percentage of the sub-bioregion area that is within the GKLaWAC RAP area.

Name	Code	Bioregion	Area (km^2)	% in GKLaWAC Country
Snowy Mountains	AUA01	Australian Alps	7131.14	2.21%

Victorian Alps	AUA02	Australian Alps	5198.66	42.24%
Wilsons Promontory	FUR01	Furneaux	411.442	0.04%
Gippsland Plain	SCP01	South East Coastal Plain	12470	58.87%
East Gippsland Lowlands	SEC01	South East Corner	6235.15	30.38%
South East Coastal Ranges	SEC02	South East Corner	17345.2	17.61%
Highlands—Southern Fall	SEH01	South Eastern Highlands	11963.3	63.45%
Highlands—Northern Fall	SEH02	South Eastern Highlands	14158.1	0.74%
Strzelecki Ranges	SEH04	South Eastern Highlands	3420.45	57.13%
Kybeyan Gourock	SEH15	South Eastern Highlands	4792.21	0%
Monaro	SEH16	South Eastern Highlands	12675.4	0.05%

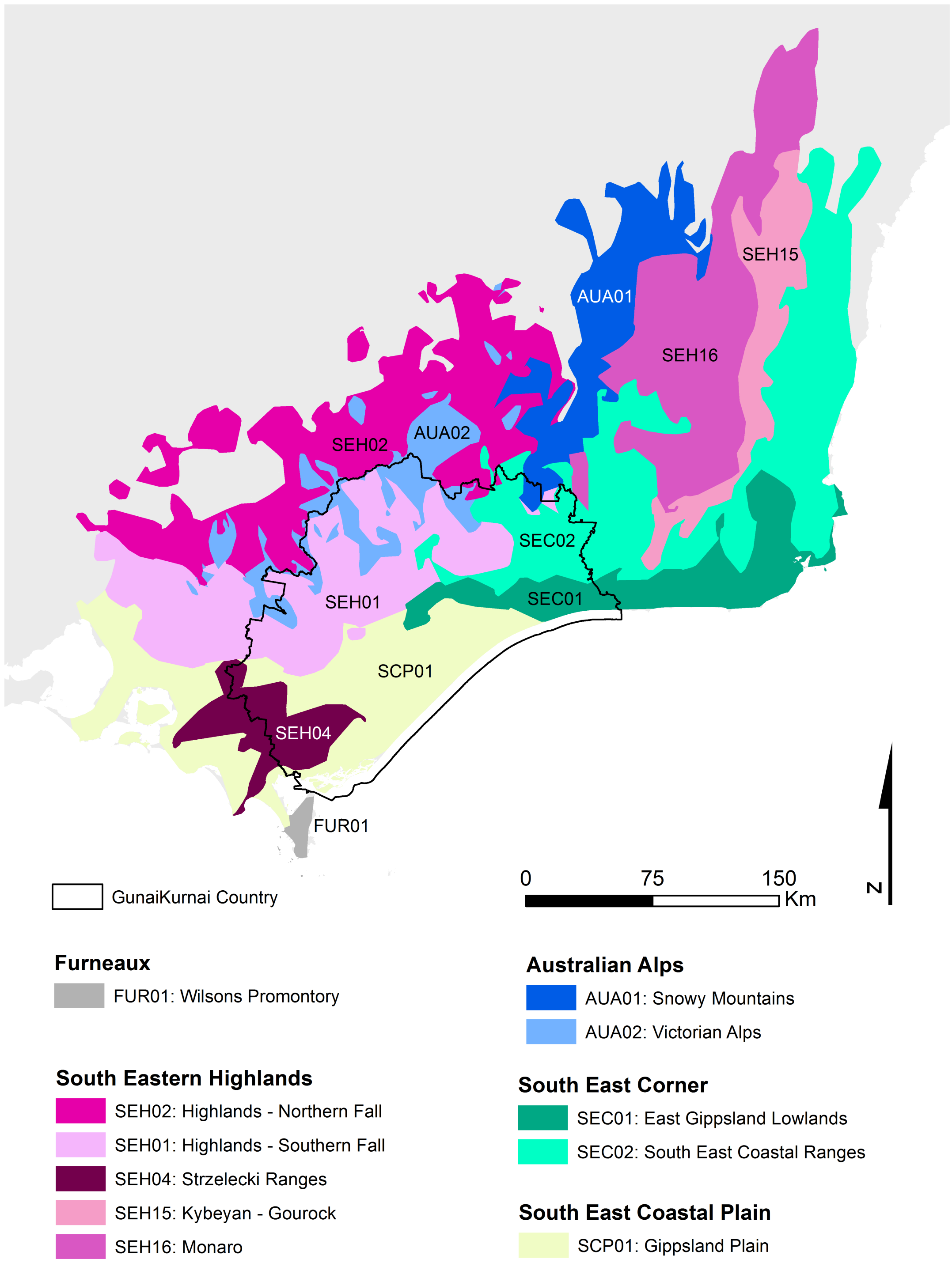


Figure 14.1. Location and extent of each IBRA sub-bioregion in and surrounding GunaiKurnai Country (black border line). Each sub-bioregion is grouped and colour-coded by the broader IBRA bioregion that it is part of; these bioregions are listed in bold in the legend.

14.1. The ecology and cultural history of the sub-bioregions of GunaiKurnai Country

Each sub-bioregion has a distinct ecology, biodiversity, and climate (Figure 14.1):

AUA01 *Snowy Mountains*: Located towards the northeast of, and intersects over, a small area only of GunaiKurnai Country. This is a mountainous environment, reaching an average elevation of 1315 m above sea level, with Eucalypt Forests and Eucalypt Woodland dominating the vegetation. Much (71%) of this sub-bioregion is under Conservation management, and 27% is under minimal human development. This is also the only sub-bioregion to have a notable amount of grassland (12%) present.

AUA02 *Victorian Alps*: Also often referred to as the "High Country", this sub-bioregion is located in the north of GunaiKurnai Country and is widely recognised for its extensive mountain system that in the GKLaWAC RAP area reaches a maximum peak of 1986 m aboe sea level (Mount Bogong), the highest peak in Victoria. Like the Snowy Mountains, this sub-bioregion is in the Australian Alps bioregion and therefore also has a high average elevation (1167 m a.s.l.). The majority of this sub-bioregion is covered by Eucalypt Woodland vegetation (54%) with intersecting Eucalypt Forest (39%) in the gullies. In the higher areas of the sub-bioregion, shrublands and grassland dominate, and towards its southern end there are some pockets of rainforest. In the Victorian Alps, there is much exposed bedrock across the entire range, and almost all of the land area (97%) is under conservation management (49%) and minimal human development (48%).

FUR01 *Wilsons Promontory*: This is a small sub-bioregion (411 km^2), being a small peninsula off the southern end of the Australian Coastline, and part of the larger "Furneaux" bioregion. Only a small area (0.04%) of this sub-bioregion intersects with the southern end of the current GunaiKurnai RAP area. This sub-bioregion is one of the 11 within this broad region that has a high proportion of shrubland relative to its total area. It contains a mix of Eucalypt Forest (28% dry sclerophyll and 10% wet sclerophyll), Shrubland (37%) and Eucalypt Woodland (18%). Of note, a pocket of wet sclerophyll forest is found in the centre of this sub-bioregion, with small patches of rainforest also surrounding and intersecting it. All of this sub-bioregion is under conservation management.

SCP01 *Gippsland Plain*: The Gippsland Plain ranks second among these 11 sub-bioregions (behind the Strzelecki Ranges) as having the most extensively modified sub-bioregion—83% of the area is under the two highest categories of human use (intensive uses 22% and production from agriculture and plantations 61%). It is also among the selection of sub-bioregions that have a high overlap within GunaiKurnai Country. This sub-bioregion is very flat, with an average elevation of 48 m a.s.l., making it well suited for human-use (agriculture and farming).

SEC01 *East Gippsland Lowlands*: This sub-bioregion is located along the southeast coastline of GunaiKurnai Country. It consists of large tracts of wet sclerophyll forest intersected with pockets of dry sclerophyll eucalypt forest throughout. There are also large areas of cleared land, but these are largely settlements and urban infrastructure rather than farming. Much of the land-use (56%) is in fact production from relatively "natural" environments.

SEC02 *South East Coastal Ranges*: This sub-bioregion has among the highest proportion of dry sclerophyll eucalypt forest (30%), but is actually also very mixed with many different vegetation types all occupying high proportions of the area: almost 30% of both eucalypt woodland, and wet sclerophyll eucalypt forest and a moderately high percent of cleared land (12%) which is found predominately in the north east portion of the sub-bioregion.

SEH01 *Highlands Southern Fall*: This sub-bioregion has the highest amount of overlap with GunaiKurnai Country (63%) of all the 11 sub-regions included in this report. It also has some of the highest coverage of wet sclerophyll eucalypt forest (61%). Much of the cleared area is towards the western half of the sub-bioregion, with mostly dry sclerophyll eucalypt forest intersecting with these areas.

SEH02 *Highlands Northern Fall*: Surrounds and hugs the northern part of the GunaiKurnai RAP area, with only a small area intersecting it (0.7%). It consists of a mixture of wet and dry sclerophyll eucalypt forest, with the wetter areas extending towards the southwestern end of the sub-bioregion, where there are also tiny pockets of rainforest (which is found nowhere else within the sub-bioregion).

SEH04 *Strzelecki Ranges*: Has the highest percentage (95%) of area used for human production—agriculture and plantations (84%) and intensive uses (11%). Although much of this sub-bioregion is heavily human-impacted, there remains a moderate amount of wet sclerophyll eucalypt forest located primarily on the eastern gullies and ridges, where there is higher rainfall and more complex topography.

SEH15 *Kybeyan Gourock*: high degree of low-level human use (production from relatively natural environments 57%) and a high percentage of nature conservation areas (30%). Of the vegetation types, wet sclerophyll eucalypt forests are the most dominant (45%), followed by a relatively high amount of cleared land (27%).

SEH16 *Monaro*: Much of the interior of this sub-bioregion is cleared, with 32% used for production from agriculture and plantations, and 52% for production from relatively natural environments. There is a small section of eucalypt woodland in the southern end of the sub-bioregion (which is the end closest to, and bordering on, the GunaiKurnai RAP area boundary), and a small amount of grassland towards its northern tip. Besides the cleared land, the dominant vegetation type is dry sclerophyll eucalypt forest (22%), located mostly around the edges of the sub-bioregion.

Table 14.2. Percentage of area each vegetation type contributes to extent of each sub-bioregion. All 11 sub-bioregions that sit within and surrounding GunaiKurnai Country are shown. All proportions greater than 30% have been shaded grey to highlight the vegetation type and its larger contribution to the area within that sub-bioregion.

					Eucalypt Forest			
Sub-bioregion	**Cleared**	**Other**	**Grassland**	**Shrubland**	**Eucalypt Woodland**	**Dry Sclerophyll**	**Wet Sclerophyll**	**Rainforest**
Snowy Mountains	1	0	12	1	34	29	21	0
Victorian Alps	0	2	1	3	54	1	38	1
Wilsons Promontory	0	2	1	37	18	28	10	3
Gippsland Plain	71	1	1	6	9	4	3	0
East Gippsland Lowlands	11	7	0	3	10	17	50	0
South East Coastal Ranges	14	3	0	1	22	30	28	1
Highlands—Southern Fall	13	0	0	2	4	20	61	1
Highlands—Northern Fall	14	0	0	0	5	27	52	0
Strzelecki Ranges	69	0	0	0	1	1	28	1
Kybeyan Gourock	27	0	0	1	14	11	45	1
Monaro	64	0	1	0	9	22	3	0

Table 14.3. Percentage of area each land-use type contributes to each sub-bioregion. All 11 sub-bioregions that sit within and surrounding GunaiKurnai Country are shown. Land-use type is in order of increasing intensity of human-use, from most intensive uses on the left to least intensive on the right. All proportions greater than 30% have been shaded grey to highlight that vegetation type and its larger contribution to the area within the sub-bioregion.

Sub-bioregion	Intensive uses	Production from agriculture and plantations	Production from relatively natural environments	Nature conservation	Water
Snowy Mountains	0	1	27	71	1
Victorian Alps	2	1	48	49	0
Wilsons Promontory	0	0	0	100	0
Gippsland Plain	22	61	3	13	1
East Gippsland Lowlands	3	15	56	26	0
South East Coastal Ranges	1	14	44	41	1
Highlands—Southern Fall	10	14	50	25	0
Highlands—Northern Fall	3	22	54	21	0
Strzelecki Ranges	11	84	1	4	0
Kybeyan Gourock	0	12	57	30	0
Monaro	4	32	52	9	4

Table 14.4. Average elevation, mean annual temperature (MAT) and mean annual precipitation (MAP) for each sub-bioregion within and surrounding GunaiKurnai Country. The means (average) and minimum and maximum values are shown for both MAT and MAP, to show variability.

Sub-bioregion	Mean annual temperature (°C)			Elevation	Mean annual precipitation (mm)		
	MIN	MAX	MEAN	MEAN	MIN	MAX	MEAN
Snowy Mountains	3.30	13.10	8.42	1315.775	570	2377	1254
Victorian Alps	5.30	12.40	8.89	1167.457	689	2308	1382
Wilsons Promontory	10.90	14.60	13.73	151.778	811	1438	1020
Gippsland Plain	12.90	14.90	14.32	47.881	561	1094	746
East Gippsland Lowlands	10.60	15.50	14.35	138.992	623	1168	910
South East Coastal Ranges	8.70	15.90	13.35	400.052	512	1300	845
Highlands—Southern Fall	7.20	14.70	12.39	449.673	602	1692	980
Highlands—Northern Fall	8.00	14.50	11.90	670.235	618	1673	1117
Strzelecki Ranges	10.70	14.40	13.39	209.872	717	1428	1037
Kybeyan Gourock	8.00	14.10	10.80	931.133	583	1428	840

Monaro	6.40	13.40	11.00	889.619	488	1640	653

14.2. In which sub-bioregions have surveys for cultural sites been undertaken in GunaiKurnai Country?

The vast majority of registered cultural sites have been identified and reported through systematic archaeological surveys undertaken for cultural heritage management assessments (occasionally, sites were individually registered by interested parties). These surveys have targeted delimited areas planned for development, such as road construction corridors. Cultural site surveys have also been undertaken for a range of monitoring programs, such as to assess the impacts of visitors on sites in the Gippsland Lakes region, or the distribution of sites in delimited areas following bushfires. Given the very selective, targeted survey locations, any extrapolation of known (registered) site distributions to the broader landscape needs to take the location and extent of the surveyed areas into account. Here we discuss where and how intensive cultural heritage site surveys have taken place by sub-bioregion.

…

14.3. The distribution of cultural sites by sub-bioregion of GunaiKurnai Country

The sub-bioregions that take up the largest area within GunaiKurnai Country are the Gippsland Plain (7343 km^2) and Highlands—Southern Fall (Figure 14.2). Around 72% (n = 1931) of all registered cultural sites are found within the Gippsland Plain sub-bioregion, compared to 8% (n = 213) in Highlands—Southern Fall, despite both covering approximately the same area of GunaiKurnai Country (Figure 14.2). This may indicate that the Gippsland Plain sub-bioregion within GunaiKurnai Country has been more intensely surveyed than the other sub-bioregions. Conversely, the Highlands—Southern Fall has few registered cultural sites for the larger area of GunaiKurnai that it contains.

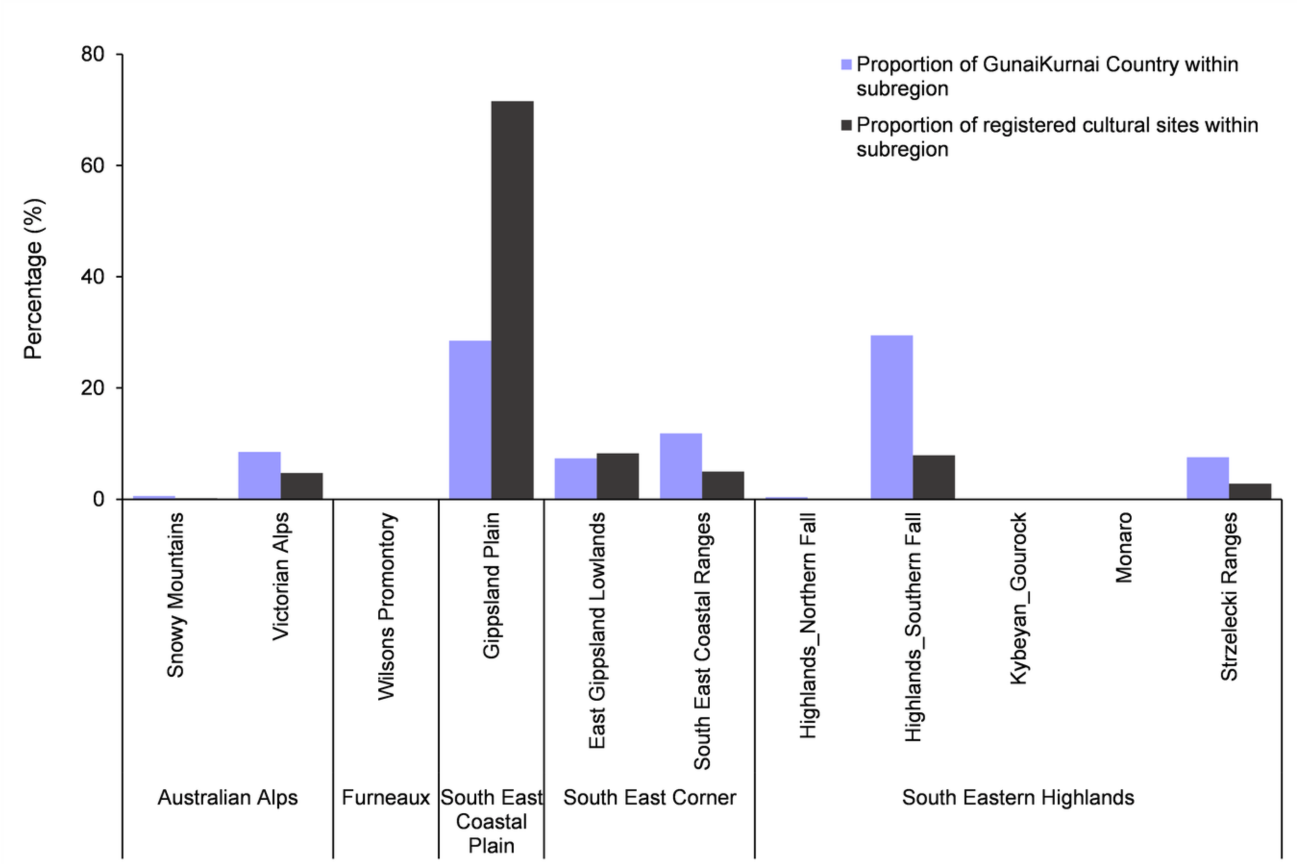


Figure 14.2. Percentage of total area of GunaiKurnai Country located within each sub-bioregion (purple bars) and proportion of total number of registered cultural sites (n = 2698) within each sub-bioregion (dark grey bars), as defined by the boundaries of the GunaiKurnai RAP area. See Figure 14.1 for a graphic representation of the sub-bioregions and how much area each covers within GunaiKurnai Country.

14.4. Fire History and Sub-bioregions in SE Australia

Here we present, for each individual sub-bioregion:

1. Area burnt by bushfires and prescribed burning in the 70 years between 1930 and 1999, and in the 20 years between 2000 and 2020.
2. Area burnt by bushfires and prescribed burning by decade.
3. A closer look at the extent of area burnt by bushfires and prescribed burning between 2000 and 2020 (the past 20 years).
4. The extent of each vegetation type present in each sub-bioregion, and area burnt by vegetation type since 2000.

For each plot of area burnt through time, we present both the non-cumulative total area and the cumulative total area burnt. In other words, we present:

1. The total (non-cumulative) area burnt in each century or decade, with each burnt area only counted once; and
2. The total area burnt per year, summed for each time category (century or decade), accounting for areas that might have been burnt more than once over that time.

Unless otherwise stated, all areas and percentages given in-text to describe the patterns in fire history and extent pertain to non-cumulative areas, representing each site only once.

Snowy Mountains. The Snowy Mountains sub-bioregion has witnessed a greater area of burning through bushfires in the past twenty years (2000–2020) than in the previous century (1900s) (Figure 14.3). Since 2000, almost the entire extent of the Snowy Mountains has been burnt by bushfires (Figure 14.5), with many areas having been burnt more than once over this time (Figure 14.3). In contrast, a greater area underwent prescribed burning in the 20th Century (1567 km^2) than in the 2000s (322 km^2; Figure 14.3).

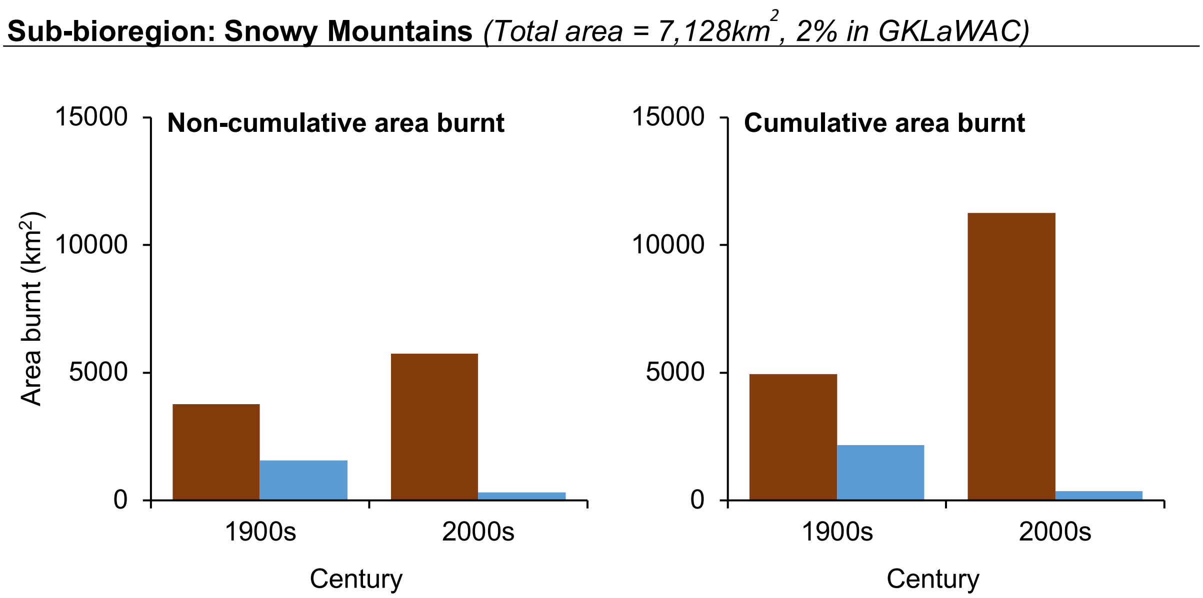


Figure 14.3. Area of the Snowy Mountains sub-bioregion burnt (km^2) in the 1900s (1930–1999) and 2000s (2000–2020). Brown bars represent fires caused by bushfire events, blue bars by prescribed burns. The plot on the left shows the total non-cumulative area burnt in each century (areas might have been burnt more than once), the plot on the right the total

area burnt per year, summed for each century (cumulative) and thereby accounting for areas burnt more than once over that time.

The decade that saw the largest area burnt by bushfires was the 2000s (4918 km^2), followed by the 2010s (2856 km^2) and the 1930s (2893 km^2). The 2000s also saw the largest cumulative area burnt by bushfires (the same locations burnt more than once per year). There were only relatively small areas burnt by bushfires in all other decades (Figure 14.4). The area burnt by prescribed burning events was consistent across all decades (average area = 273 km^2, non-cumulative), with very few areas burnt more than once by prescribed burns (Figure 14.4).

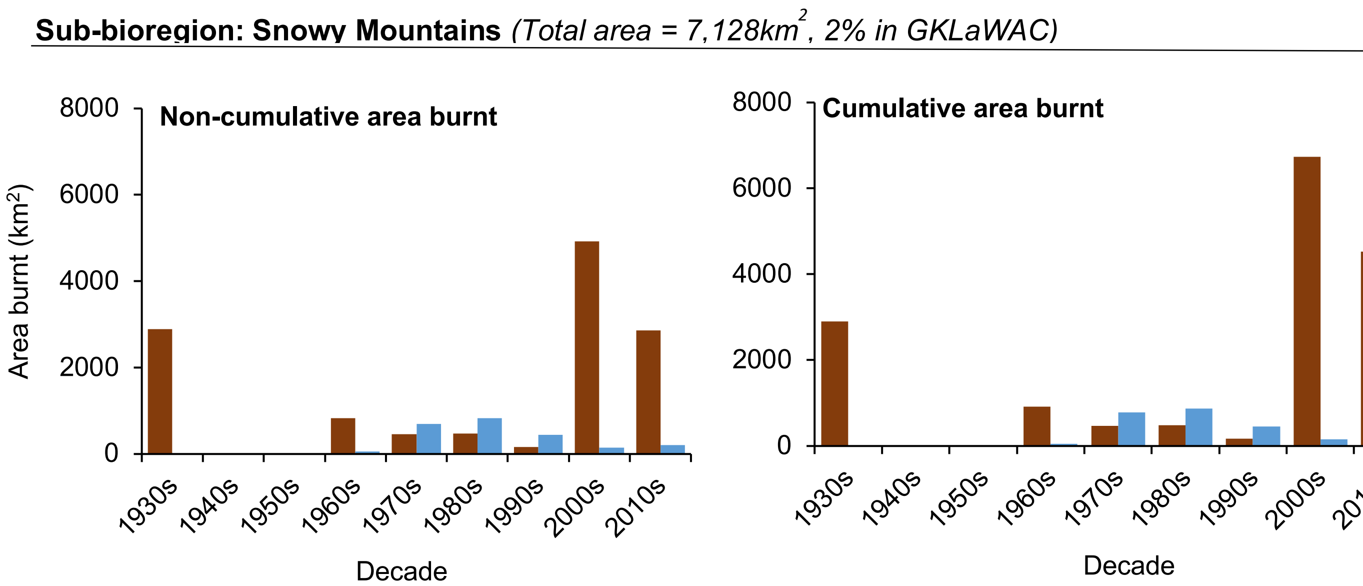


Figure 14.4. Extent of the Snowy Mountains sub-bioregion burnt (km^2) in each decade from the 1930s to 2010s. Brown bars represent areas burnt by bushfires, blue bars by prescribed burns. The plot on the left shows the total non-cumulative area burnt in each decade (areas might have been burnt more than once), the plot on the right the total area burnt per year, summed for each decade (cumulative) and thereby accounting for areas burnt more than once over that time.

Much of the Snowy Mountains sub-bioregion (87%) has been burnt by bushfires since 2000. Much of the area burnt by bushfire is proportional to the total area of each vegetation type within the sub-bioregion (Figure 14.5). Prescribed burning has only burnt across 5% of the total extent of the sub-bioregion, and much of this occurred in the Eucalpyt Woodland (2.3%, 150 km^2) and Dry Sclerophyll Eucalypt Forest (1.8%, 117 km^2).

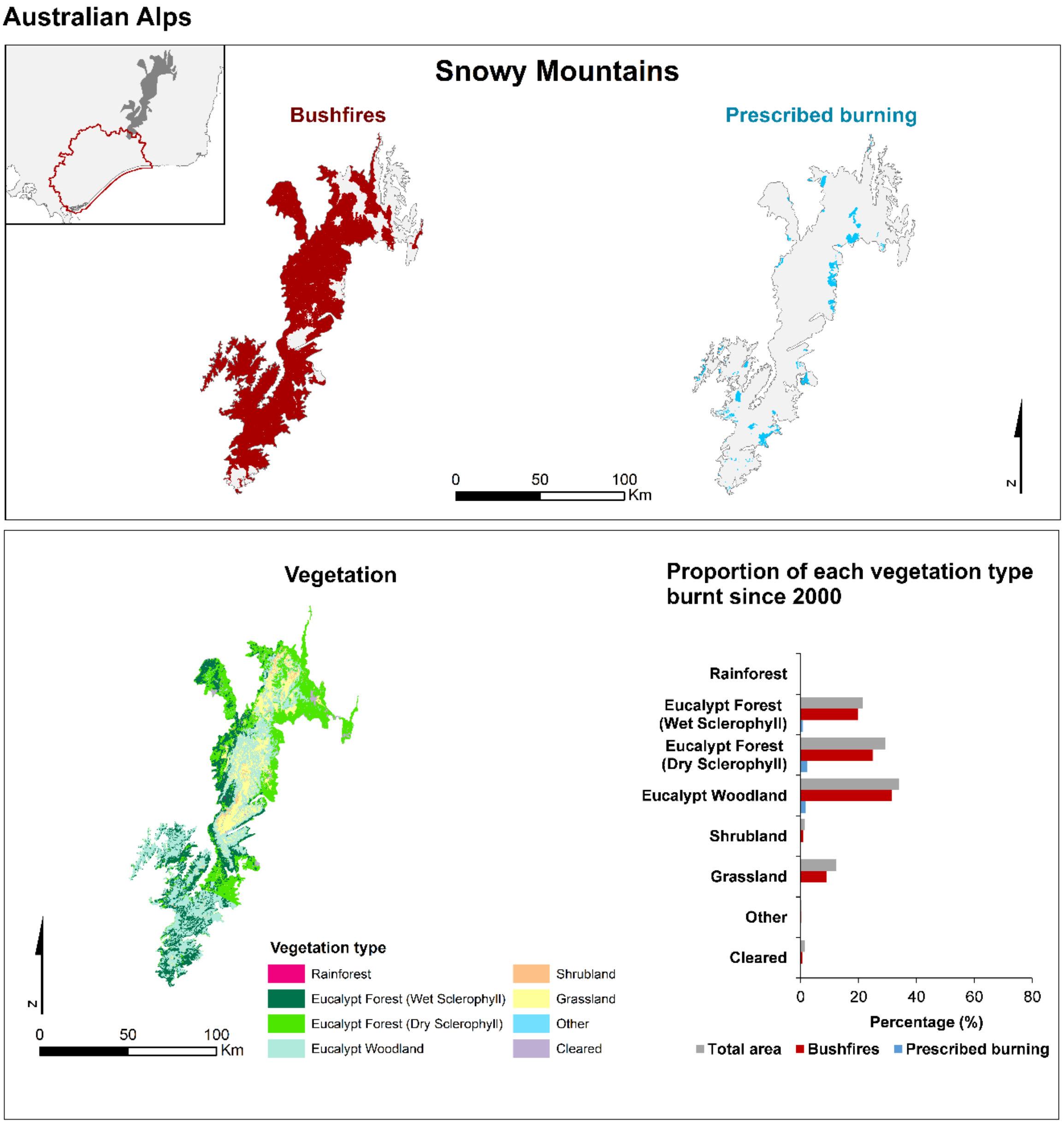


Figure 14.5. Top panel: Extent of bushfires (left, in red) and prescribed burns (right, blue) in the Snowy Mountains sub-bioregion since 2000. Bottom panel: Left: Extent of each of the different vegetation types present within the sub-bioregion. Right: Area burnt since 2000, by vegetation type.

Victorian Alps. The Victorian Alps sub-bioregion has had more non-cumulative area burnt by bushfires between 1930–1999 than between 2000–2020 (Figure 14.6). However, this pattern flips when areas burnt more than once are taken into account (cumulative area burnt): a much larger area burned in the 20 years of the 21st century than in the 70 years of the 20th (Figures 14.3, 14.6). In contrast, the area burnt by prescribed burns was higher in the 20th century (4924 km^2) than in the 2000s (4434 km^2; Figure 14.6).

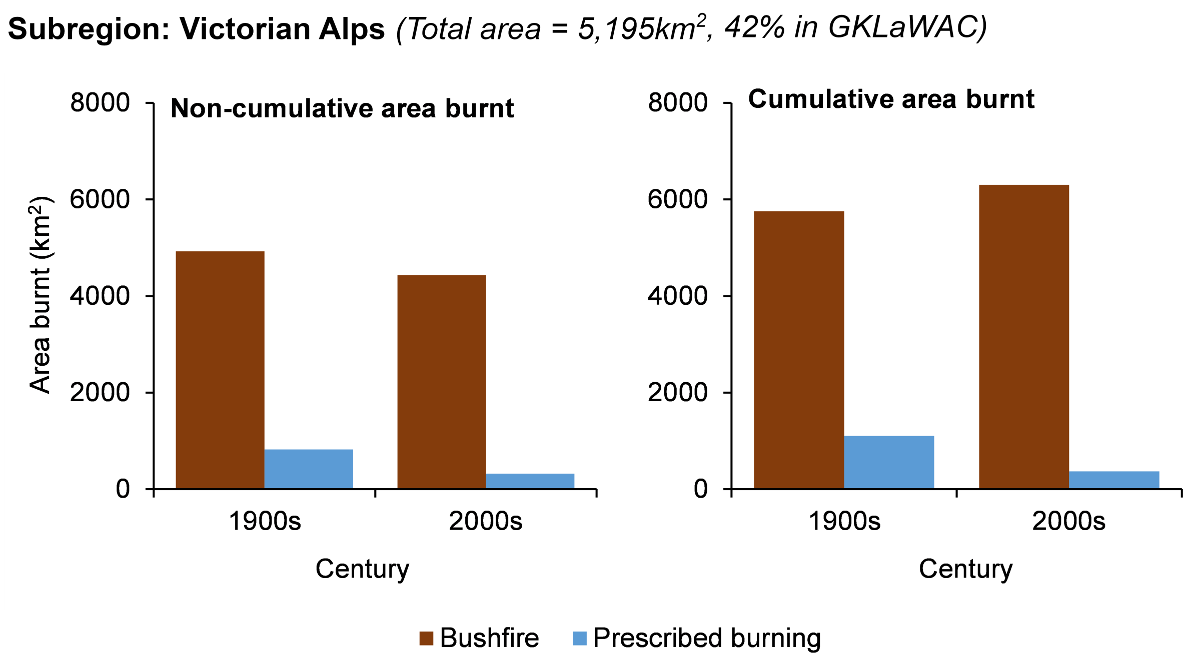


Figure 14.6. Extent of the Victorian Alps sub-bioregion burnt (km^2) in the 1900s (1930–1999) and 2000s (2000–2020). Brown bars represent fires caused by bushfire events, blue bars by prescribed burns. The left plot shows the total non-cumulative area burnt in the 1900s vs. 2000s (areas might have been burnt more than once). The right plot shows the total area burnt per year, summed for each century (cumulative); this accounts for areas that might have been burnt more than once during that time.

The decade that saw the largest area burnt by bushfires was the 1930s (4846 km^2), followed by the 2000s (4399 km^2). There was very little difference between the non-cumulative and cumulative areas burnt, meaning that few locations burnt multiple times in each decade (Figure 14.7). Relatively few, small areas burnt by bushfires in all other decades, especially from the 1940s to 1990s (Figure 14.7). On the other hand, the area burnt by prescribed burning was double that of bushfires for the 1980s (prescribed burns: 495 km^2, bushfires: 239 km^2) and 1990s (prescribed burns: 467 km^2, bushfires: 231 km^2), with very few areas burnt by prescribed burns in the other decades (Figure 14.7).

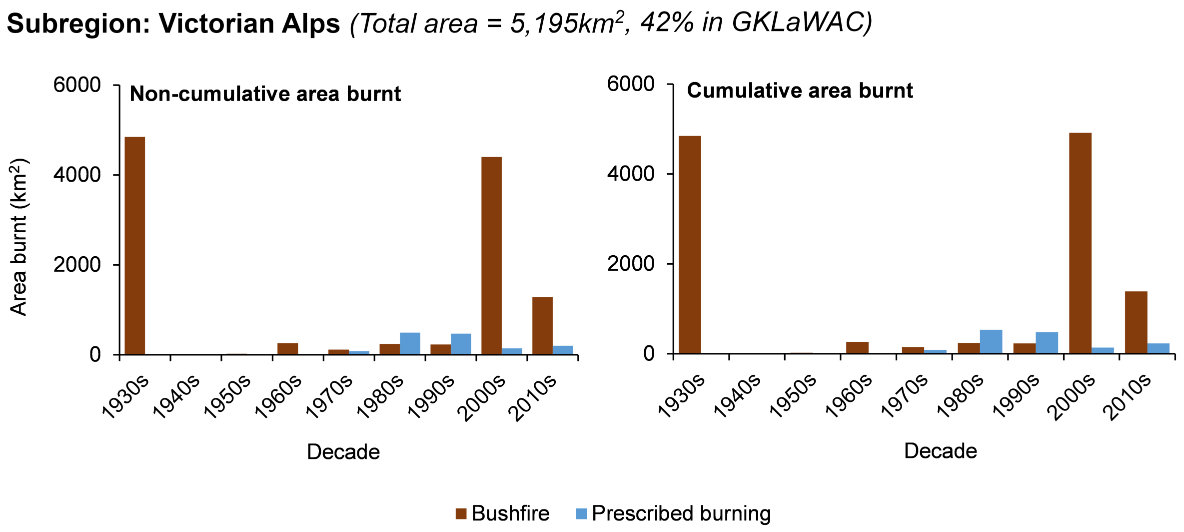


Figure 14.7. Extent of the Victorian Alps sub-bioregion burnt (km^2) in each decade from the 1930s to 2010s. Brown bars represent areas burnt by bushfires, blue bars by prescribed burns. The left plot shows the total area burnt in each decade (non-cumulative: areas might have burnt more than once), and the right plot shows the total cumulative area burnt per year, summed for each decade; this accounts for areas that may have burnt more than once over that time.

Much of the entire extent of the Victorian Alps sub-bioregion (85%) has been burnt by bushfires since 2000. Almost all of the total area covered by eucalypt woodland has been burnt by bushfires (94%), whereas only 74% of wet sclerophyll eucalypt forests have been burnt by bushfires (Figure 14.8). Prescribed burning has burnt only 6.7% of the total area of the sub-bioregion, and much of this occurred in eucalypt woodland (3.8%, 202 km^2) and wet sclerophyll eucalypt forests (2.2%, 118 km^2). A small pocket of the southwestern end of the sub-bioregion has not been burnt by bushfire and only slightly by prescribed burning (Figure 14.8).

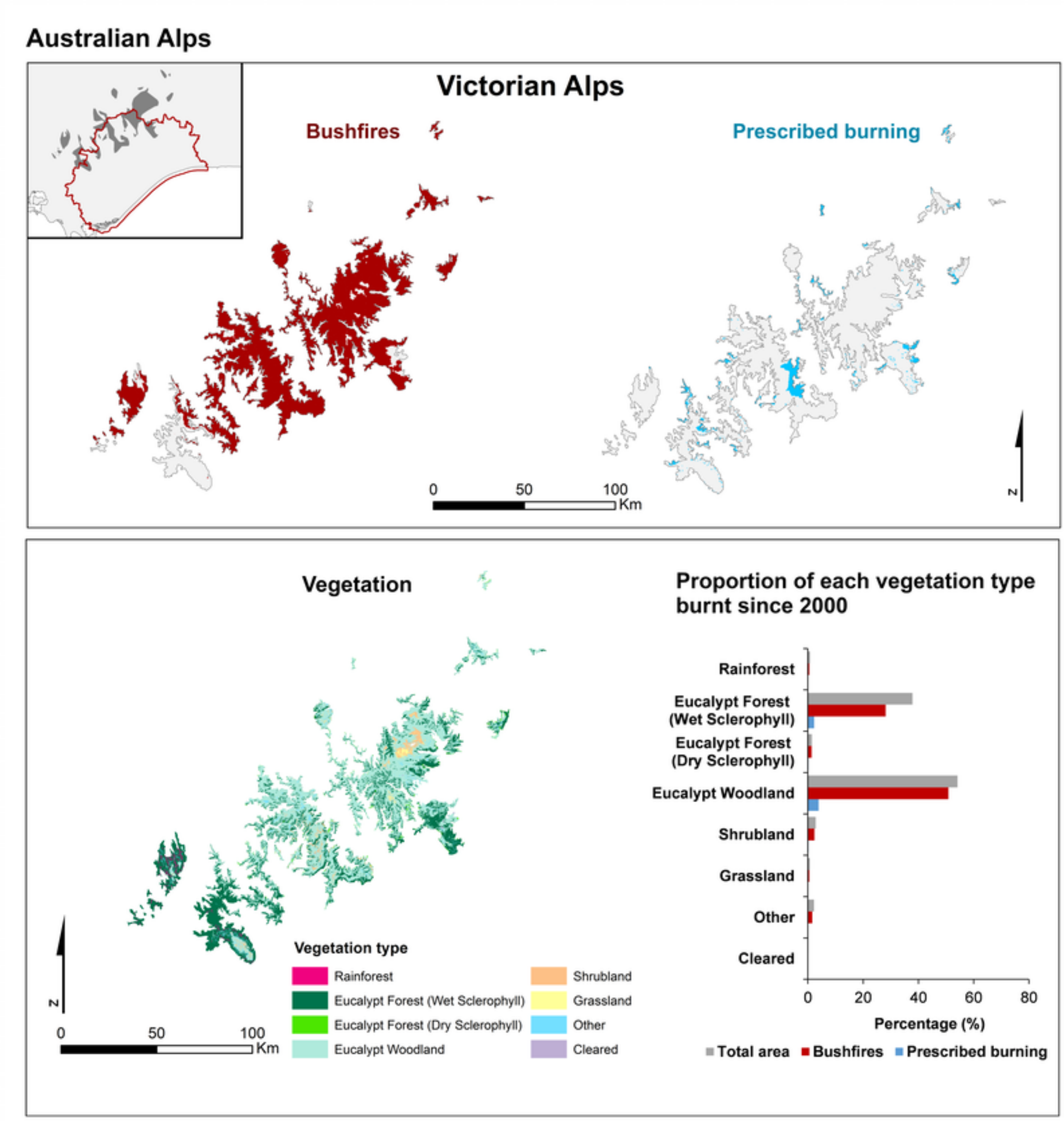


Figure 14.8. Top panel: Extent of bushfires (left, in red) and prescribed burns (right, blue) in the Victorian Alps sub-bioregion since 2000. Bottom panel: Left: Extent of each vegetation type in the sub-bioregion. Right: Graphic representation of area burnt since 2000, by vegetation type.

Wilsons Promontory. The Wilsons Promontory sub-bioregion has seen more non-cumulative area burnt by bushfires between 1930–1999 than between 2000–2020, and this pattern holds true for cumulative areas burnt also (area burnt multiple times) (Figure 14.9). However, there was no increase in cumulative area burnt in the 2000s compared to the 20th century, where it is clear during this time period, that fires occurred more often in the same locations (Figure 14.9). While the total area burnt by prescribed burns was small in both centuries, it was slightly higher in the 20th Century than in the 21st (Figure 14.9).

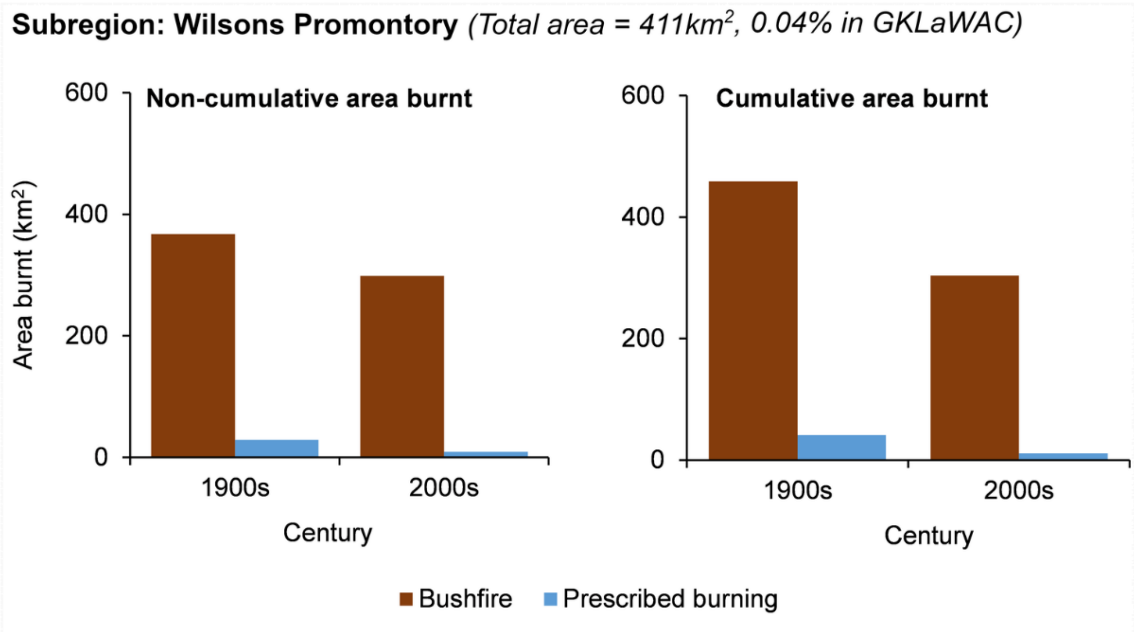


Figure 14.9. Extent of the Wilsons Promontory sub-bioregion burnt (km^2) in the 1900s (1930–1999) and 2000s (2000–2020). Brown bars represent areas burnt by bushfires, blue bars by prescribed burns. The left plot shows the total non-cumulative areas burnt in each century (areas might have been burnt more than once), the right plot total areas burnt per year, summed for each century (cumulative); this accounts for areas burnt more than once during those times.

The decade that saw the largest area burnt by bushfires was the 2000s (299 km^2, 73% of the total sub-bioregion area), followed by the 1950s (255 km^2, 62% of the total sub-bioregion area). There was very little difference between the non-cumulative and cumulative areas burnt. That is, this sub-bioregion witnessed few locations that burnt multiple times in each decade (Figure 14.10). The area burnt by prescribed fires was small across all decades, perhaps owing to the sub-bioregion's small total area (411 km^2).

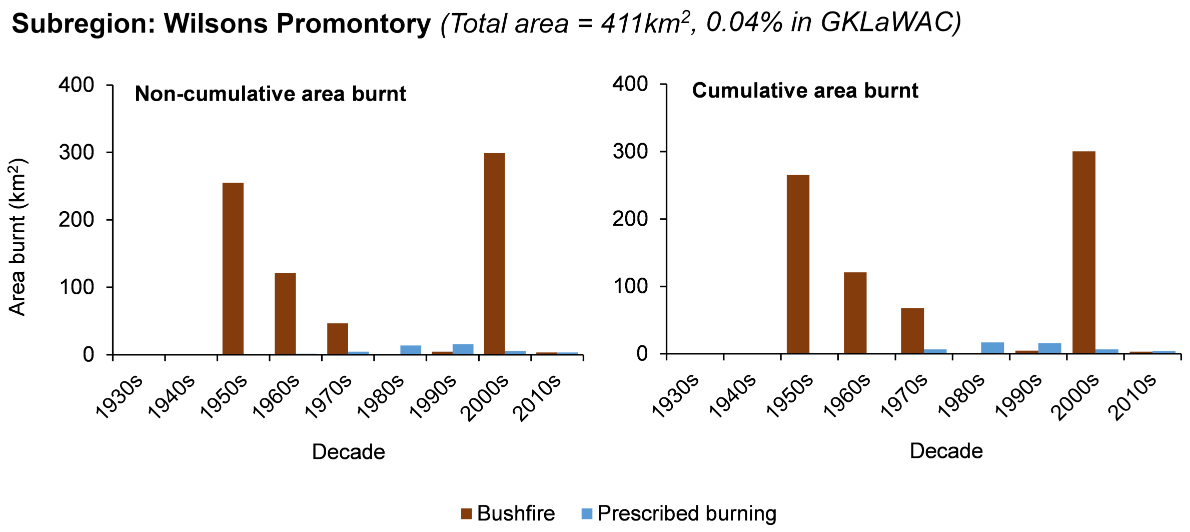


Figure 14.10. Extent of the Wilsons Promontory sub-bioregion burnt (km^2) in each decade from the 1930s to 2010s. Brown bars represent bushfires, blue bars prescribed burns. The left plot shows the total area burnt in each decade (non-cumulative: areas may have burnt more than once), the right plot total cumulative areas burnt per year, summed for each decade; this accounts for areas burnt more than once over those periods.

The Wilsons Promontory sub-bioregion covers a relatively small area, with most vegetation types covering less than 100 km^2 in area. Of this small area, 74% (299 km^2) has been burnt by bushfires, and 2.5% by prescribed burning (Figure 14.11). Shrublands make up the majority of the sub-bioregion, and thus has the highest percentage area burnt across all vegetation types. The pocket of wet sclerophyll with intersecting rainforest towards the centre of the sub-bioregion remained largely unburnt since 2000 (Figure 14.11).

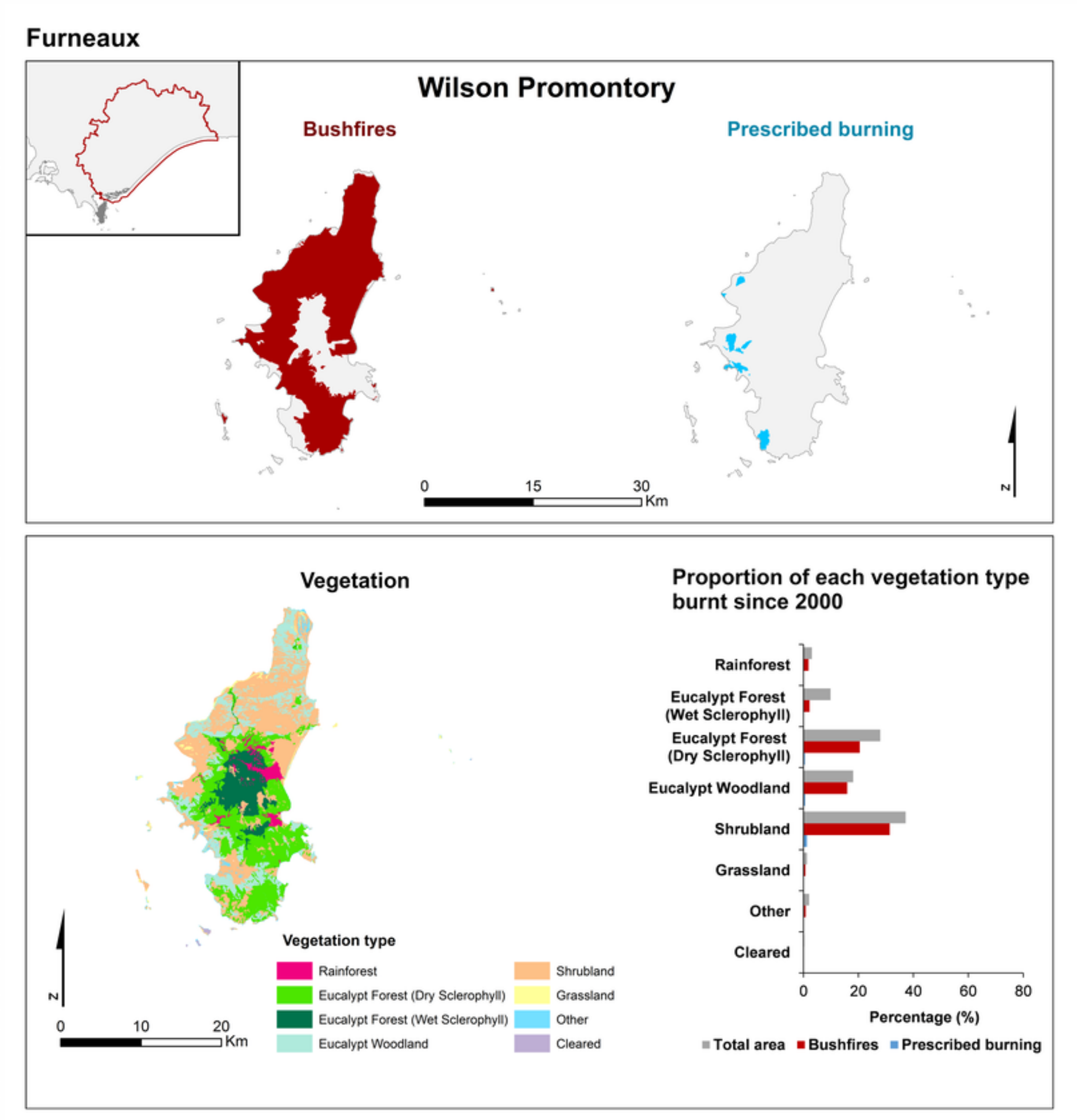


Figure 14.11. Top panel: Extent of bushfires (left, in red) and prescribed burns (right, blue) in the Wlsons Promontory sub-bioregion since 2000. Bottom panel: Left: Extent of each vegetation type present in the sub-bioregion. Right: Graphic representation of the area burnt since 2000, by vegetation type.

Gippsland Plain. Even though more non-cumulative area was burnt by bushfires between 1930–1999 than in the past twenty years (2000–2020), a relatively small proportion of the total area has burnt during each phase (7.5% and 4.5%, of the total area, respectively). While the total area burnt by prescribed burns was also low in both periods, it was slightly higher between 2000–2020 than in the 1900s (Figure 14.12).

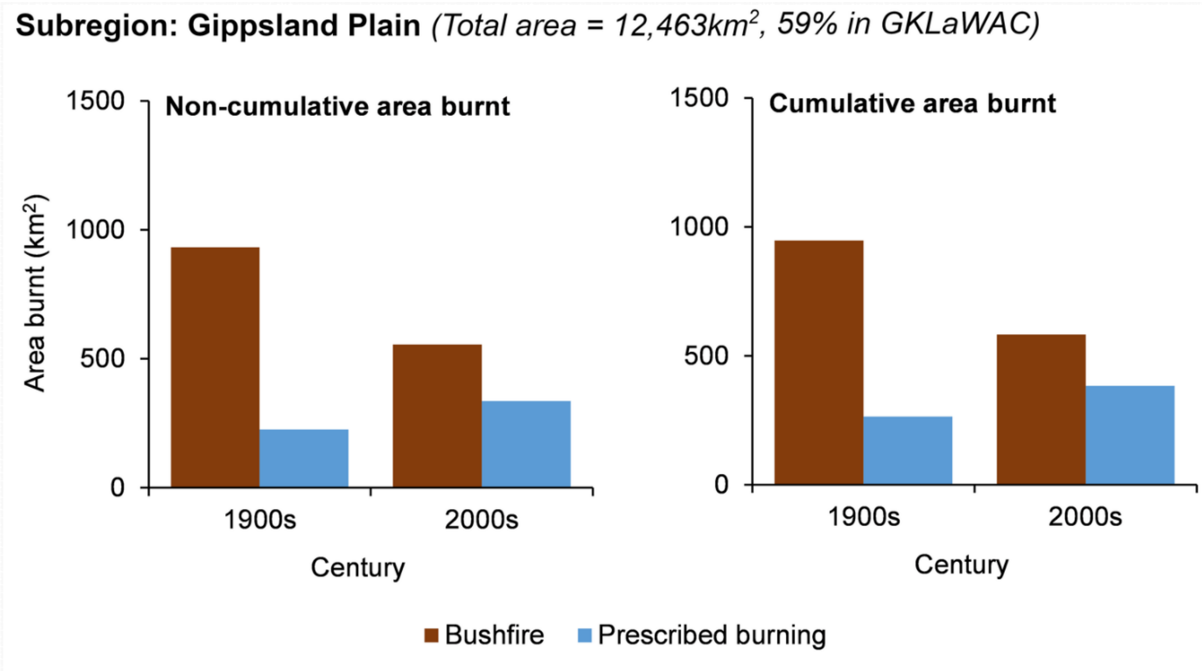
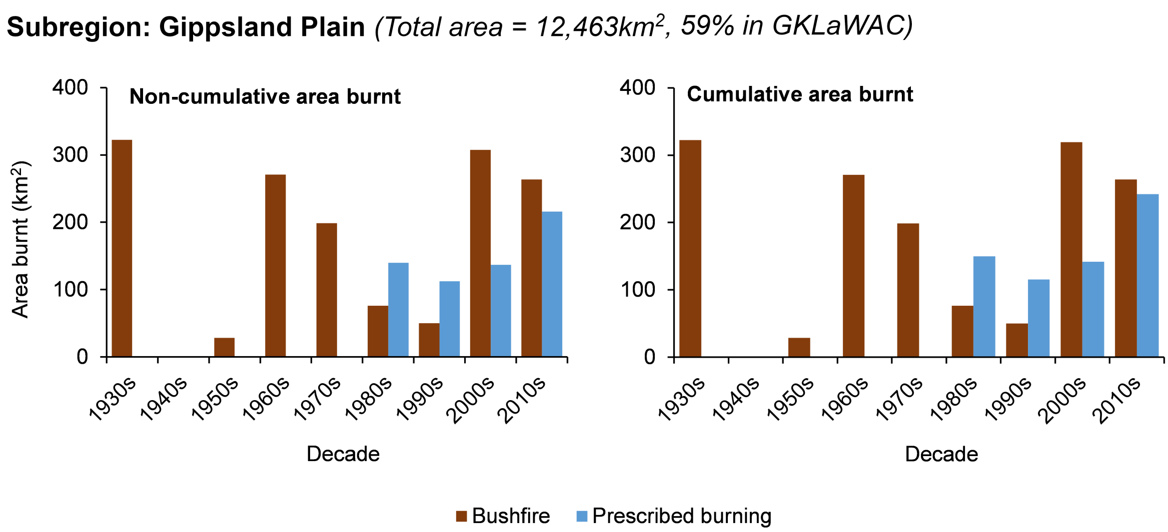
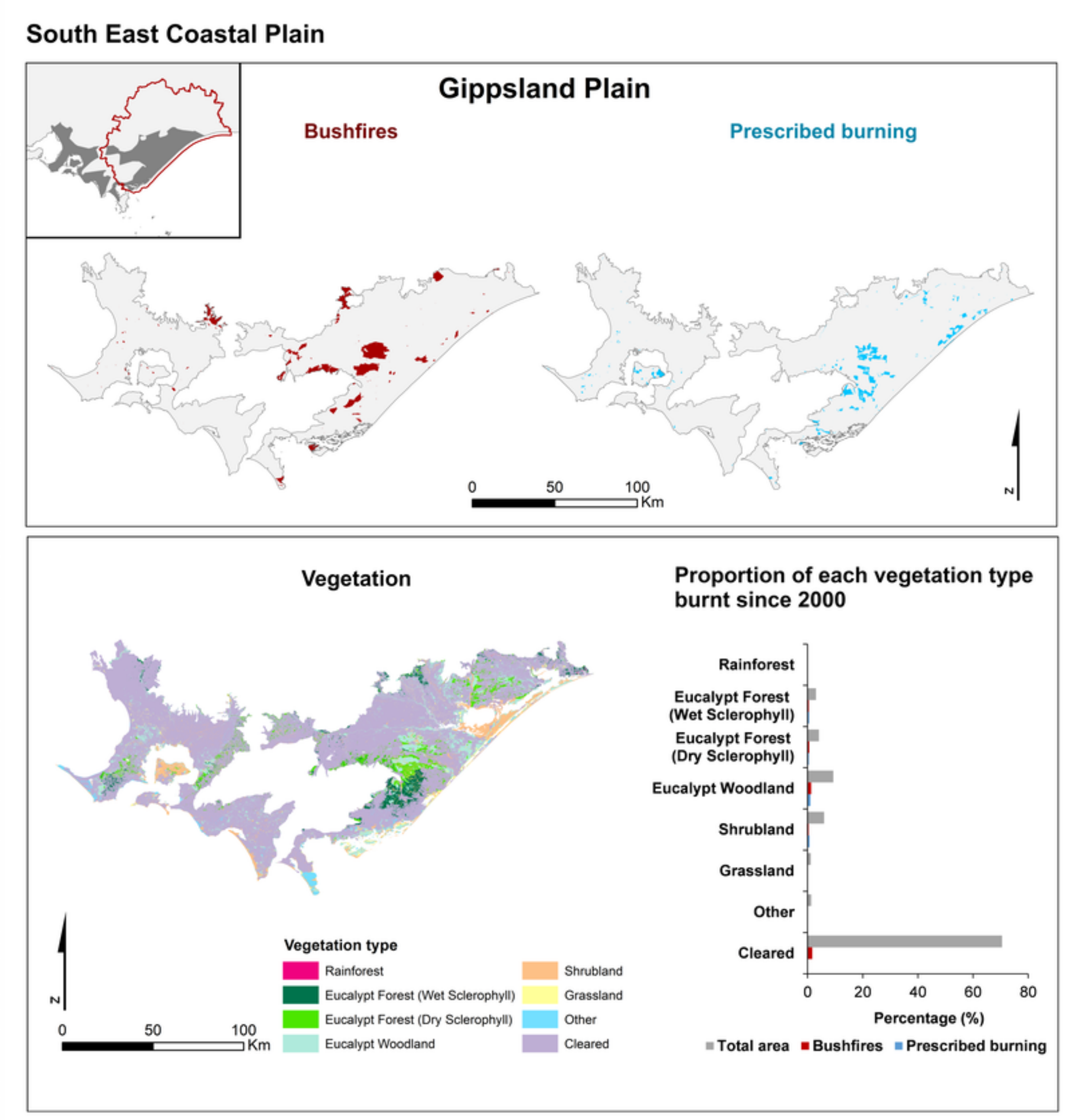


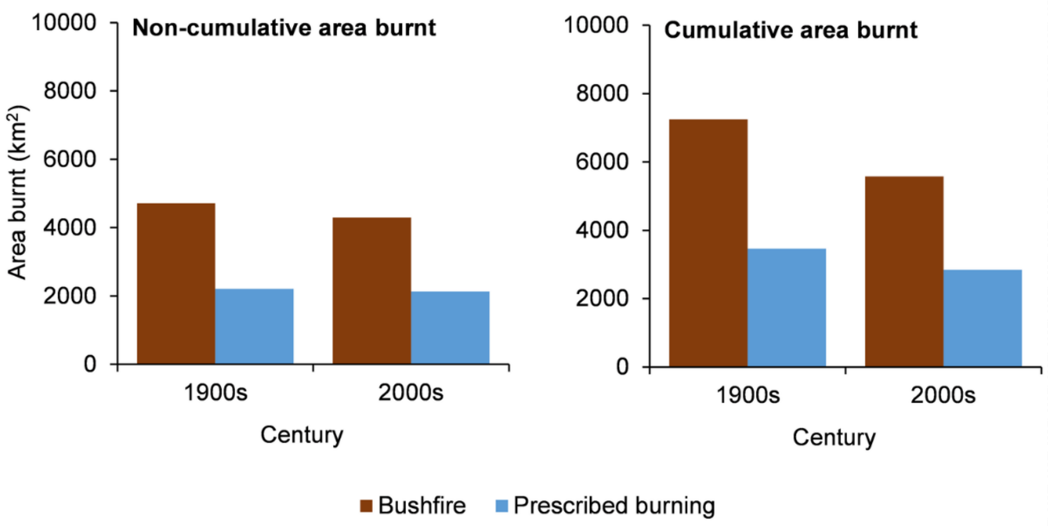
Figure 14.12. Extent of the Gippsland Plain sub-bioregion burnt (km^2) in the 1900s (1930–1999) and 2000s (2000–2020). Brown bars represent areas burnt by bushfires, blue bars by prescribed burns. The left plot shows total non-cumulative areas burnt during each century (areas may have been burnt more than once), the right plot total areas burnt per year, summed for each century (cumulative); this accounts for areas burnt more than once over those times.



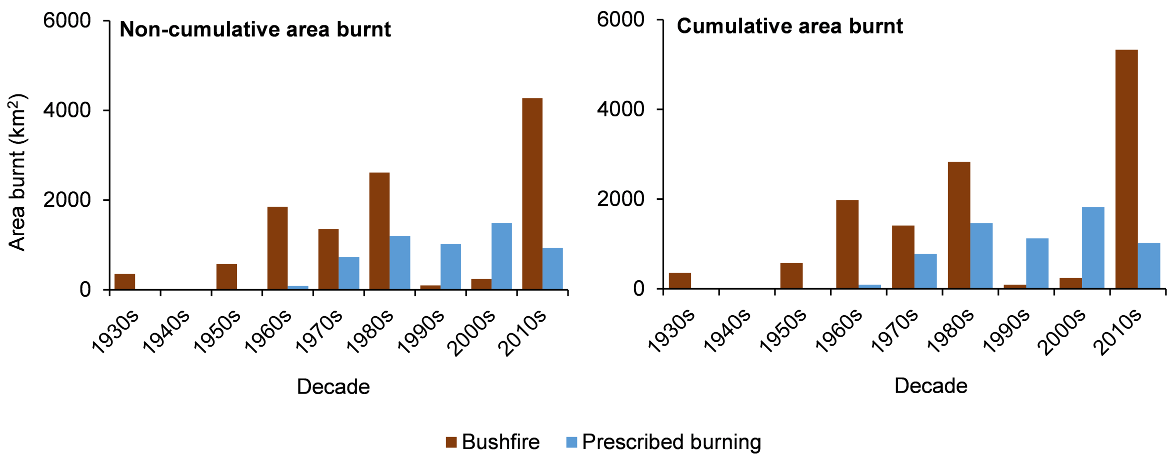


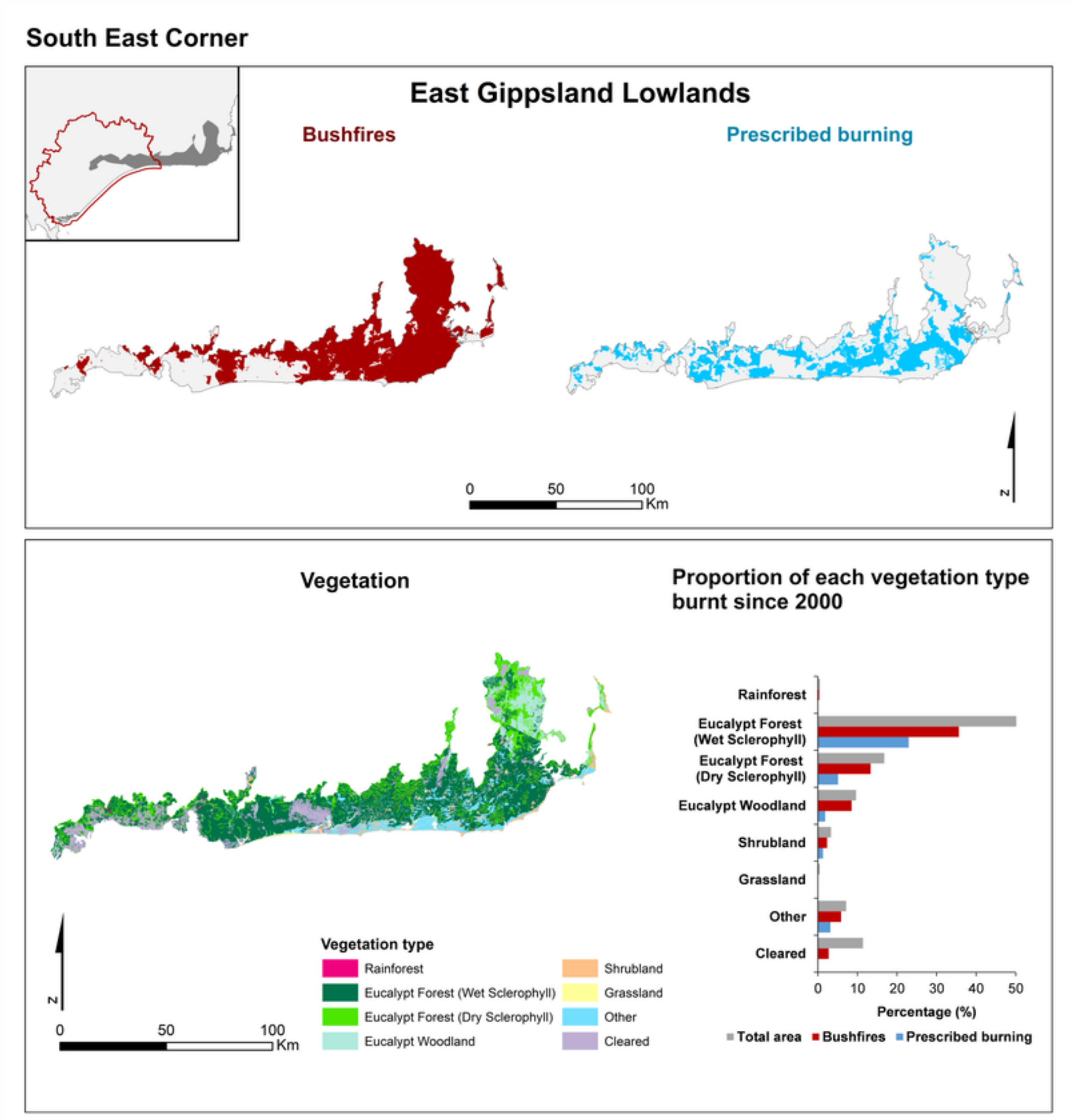
East Gippsland Lowlands.

Subregion: East Gippsland Lowlands *(Total area = 6,235km², 30% in GKLaWAC)*



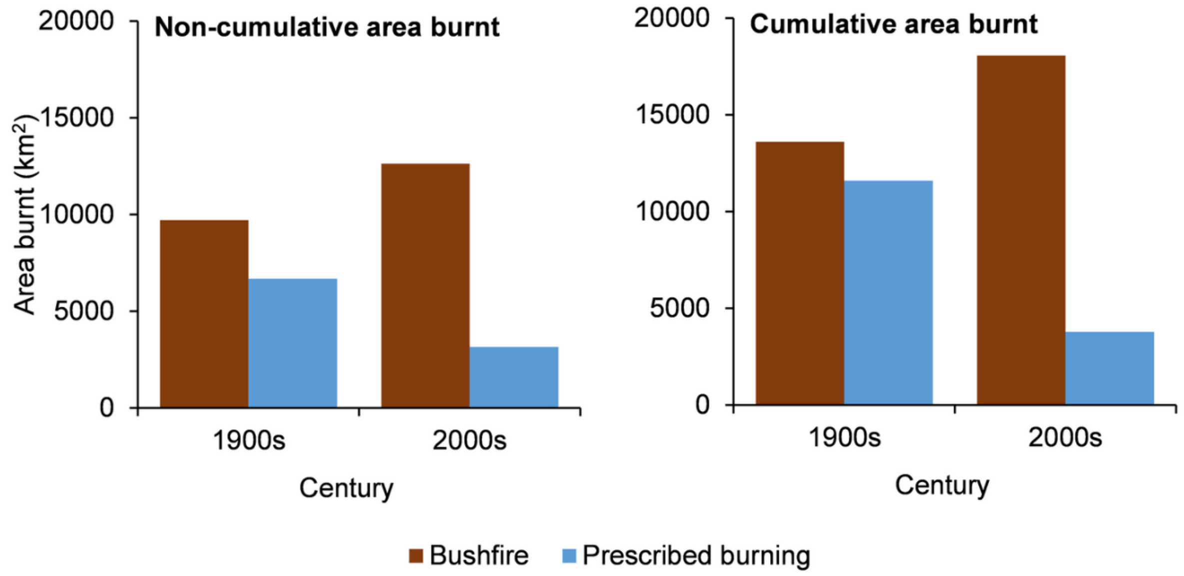
Subregion: East Gippsland Lowlands *(Total area = 6,235km², 30% in GKLaWAC)*



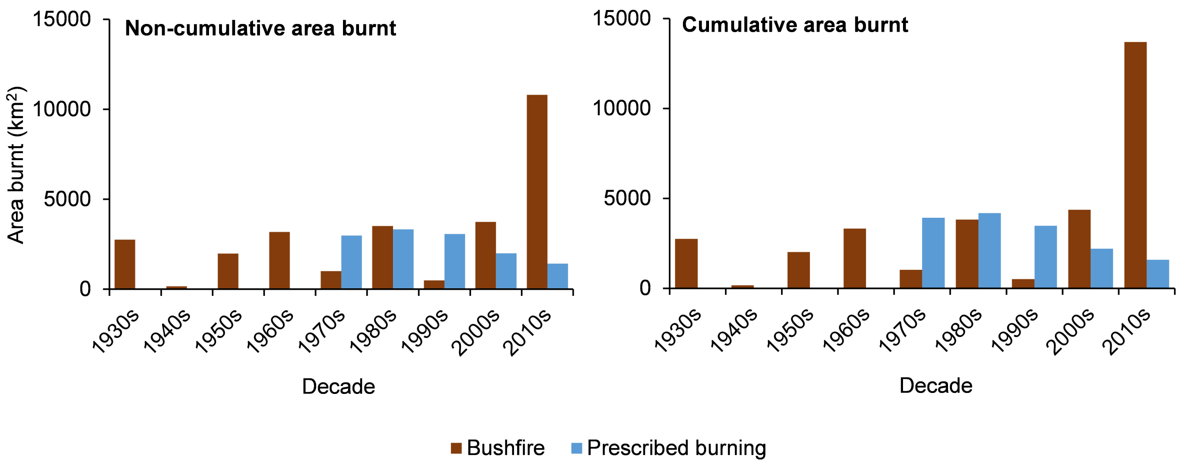


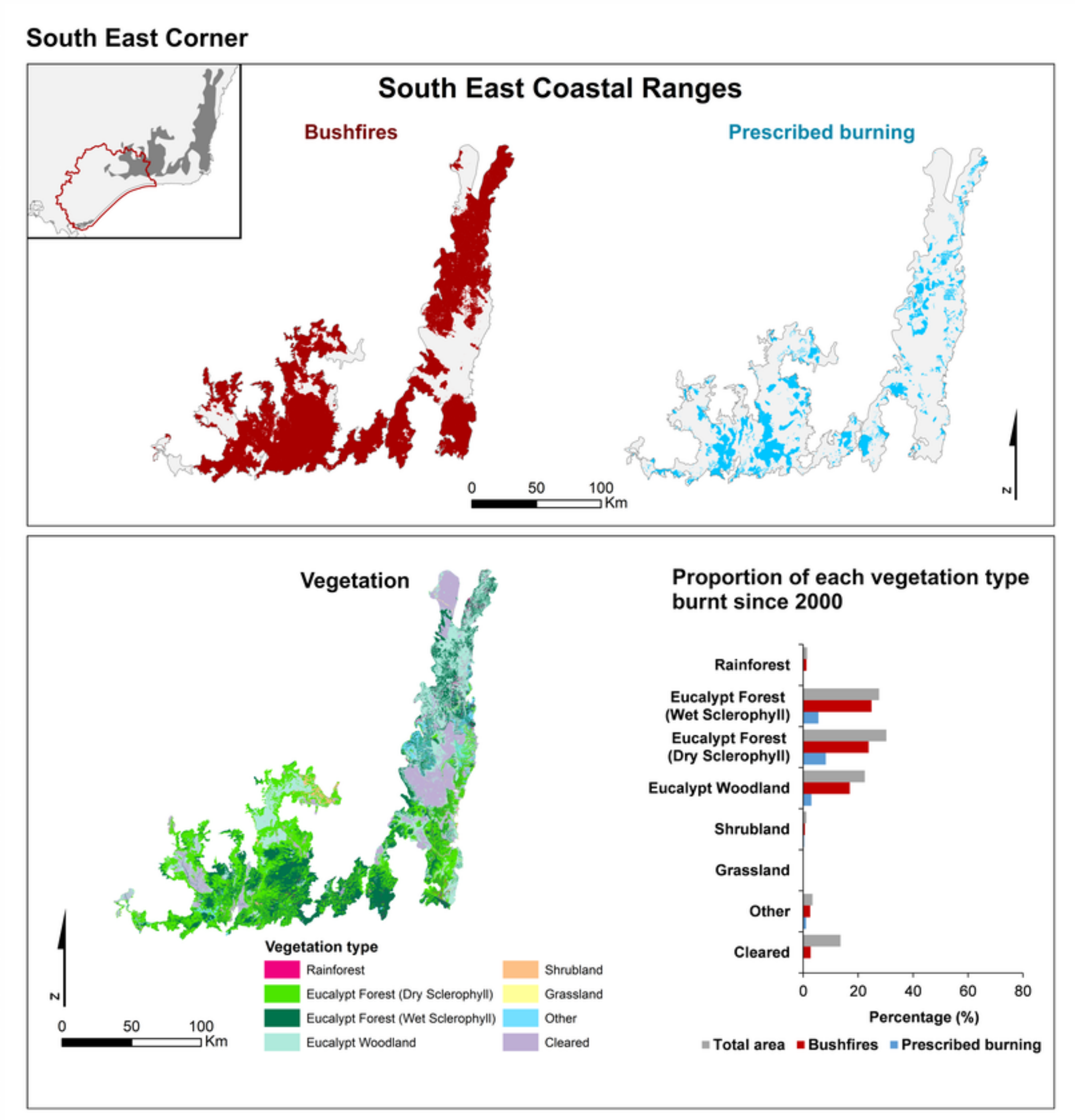
South East Coastal Ranges.

Subregion: South East Coastal Ranges *(Total area = 17,348km², 18% in GKLaWAC)*



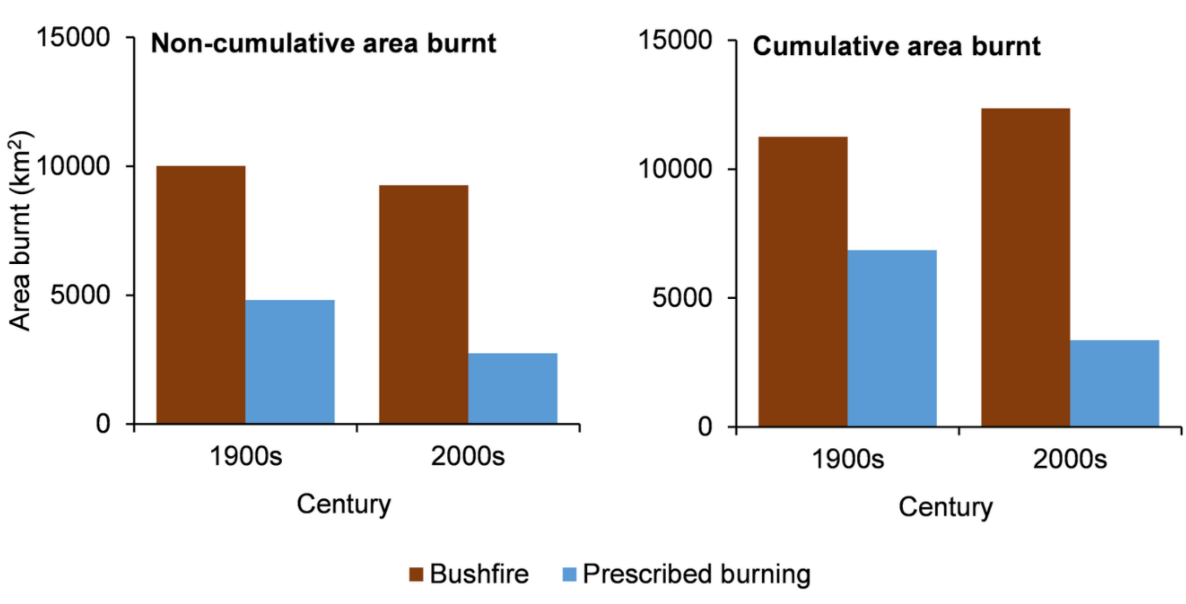
Subregion: South East Coastal Ranges *(Total area = 17,348km², 18% in GKLaWAC)*



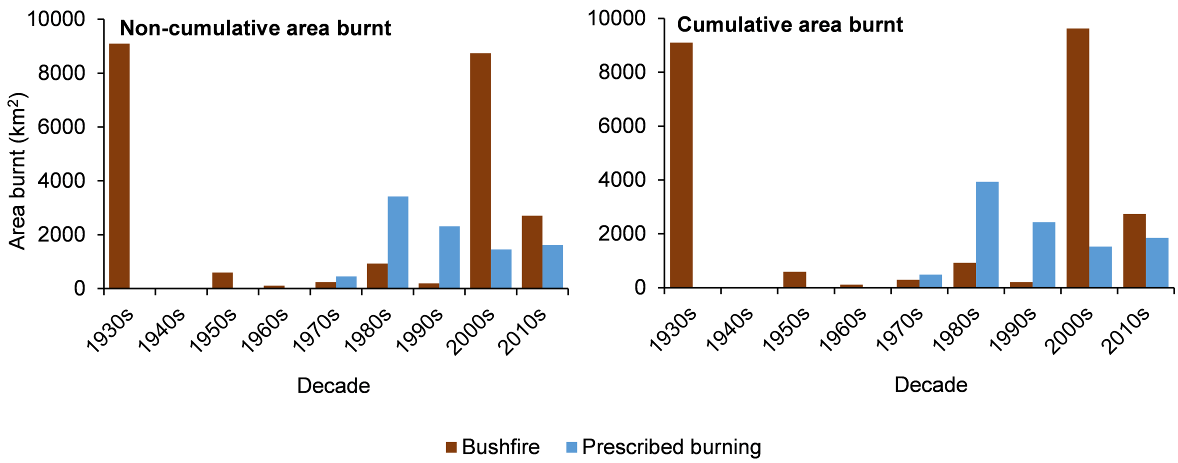


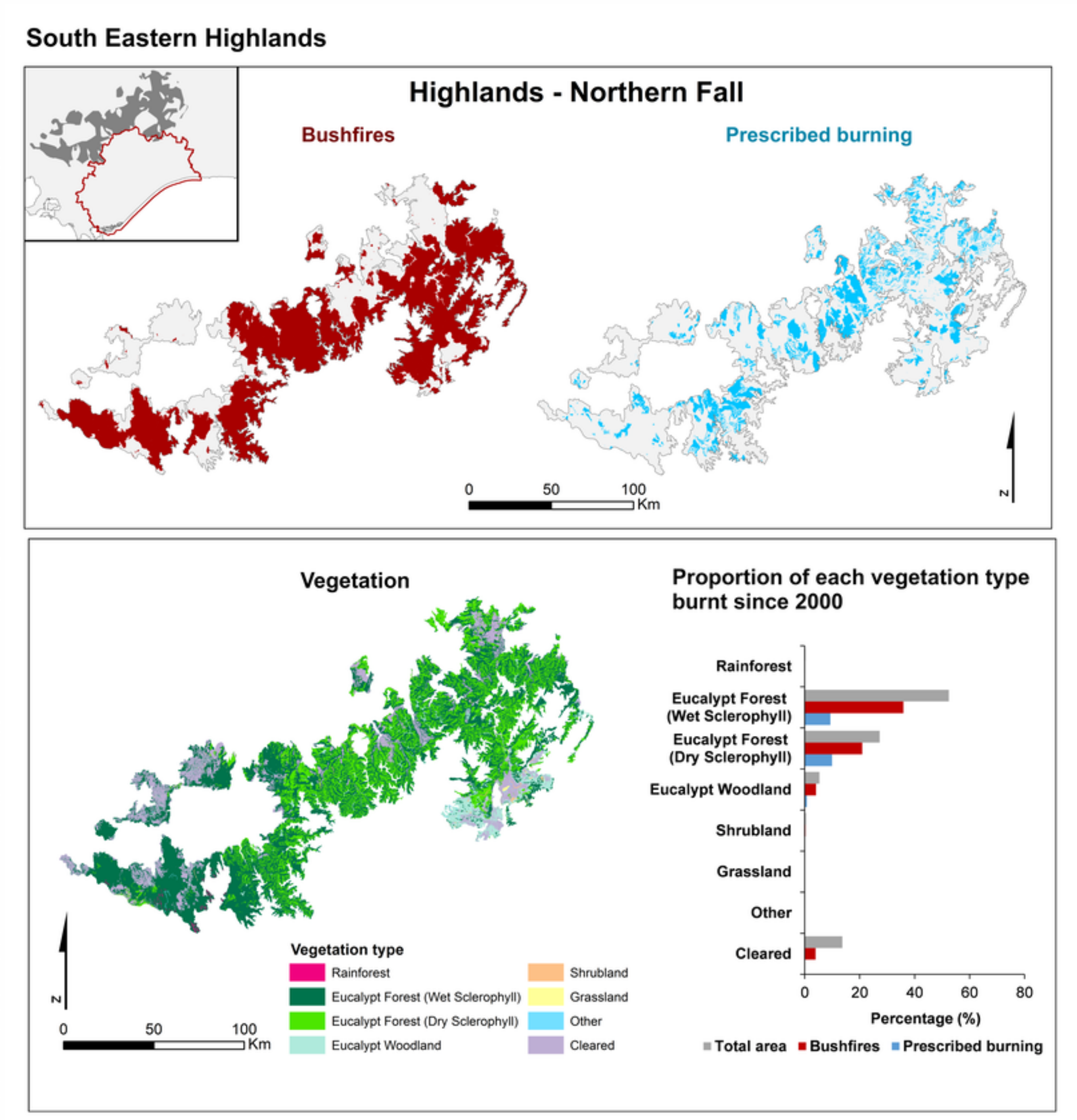
Highlands Northern Fall.

Subregion: Highlands - Northern Fall *(Total area = 14,149km², 0.7% in GKLaWAC)*

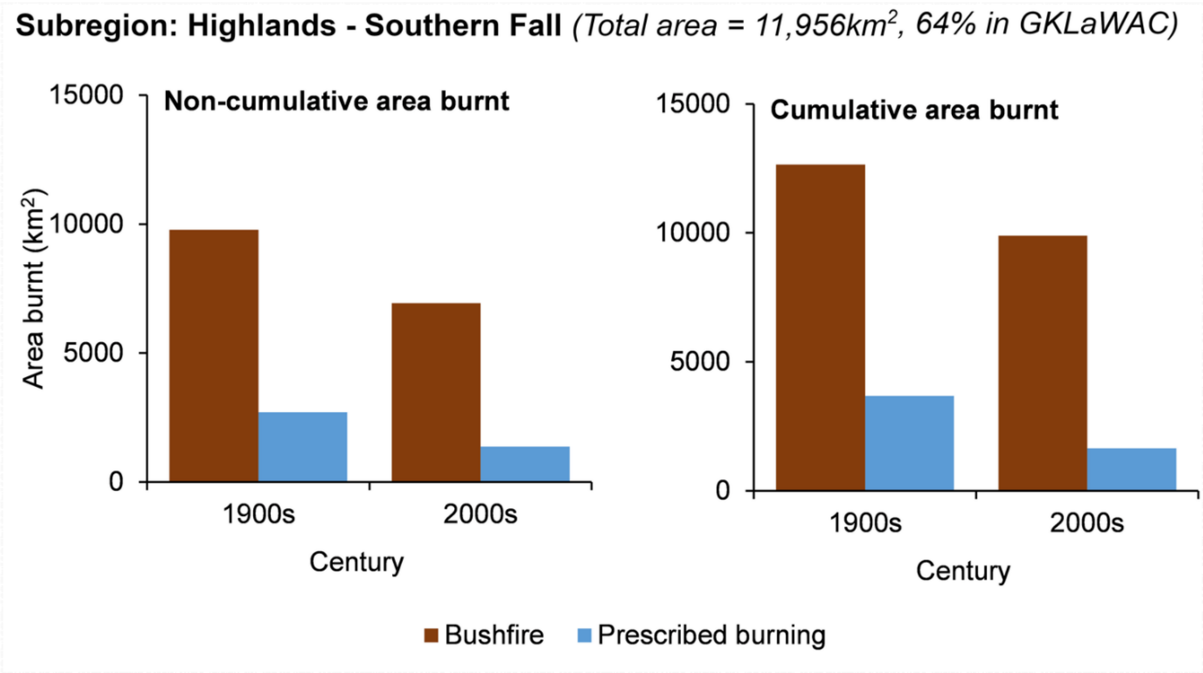


Subregion: Highlands - Northern Fall *(Total area = 14,149km², 0.7% in GKLaWAC)*

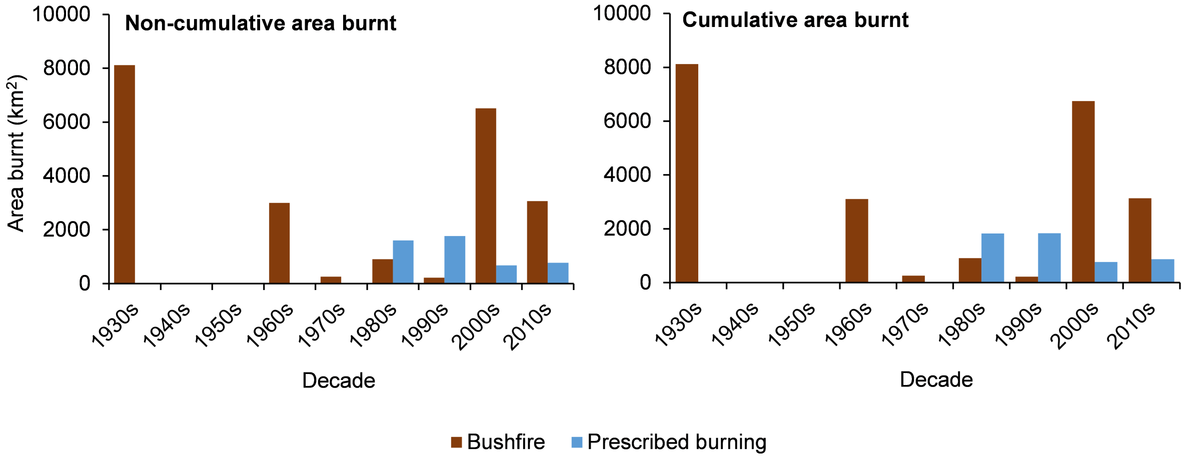


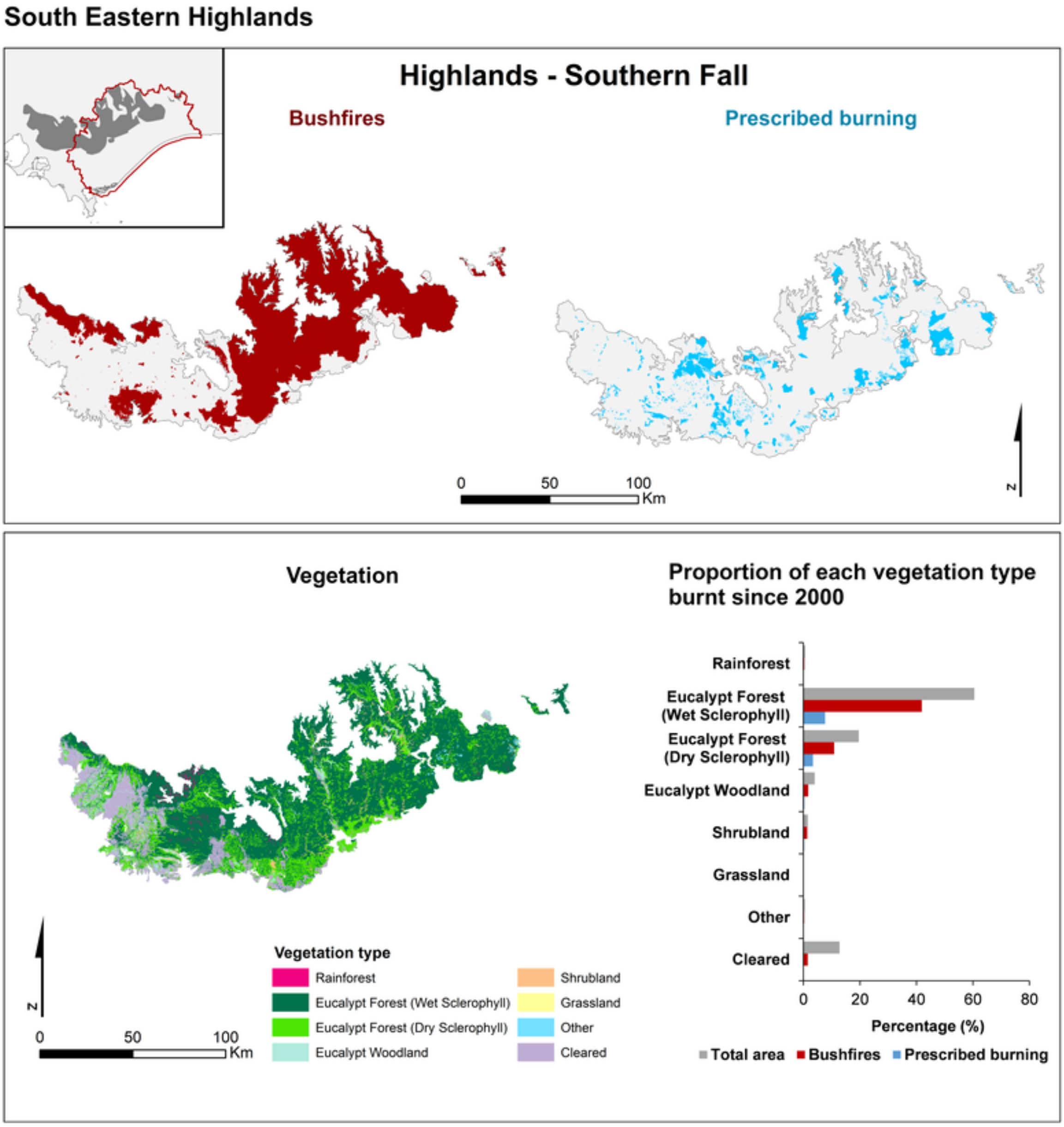


Highlands Southern Fall.



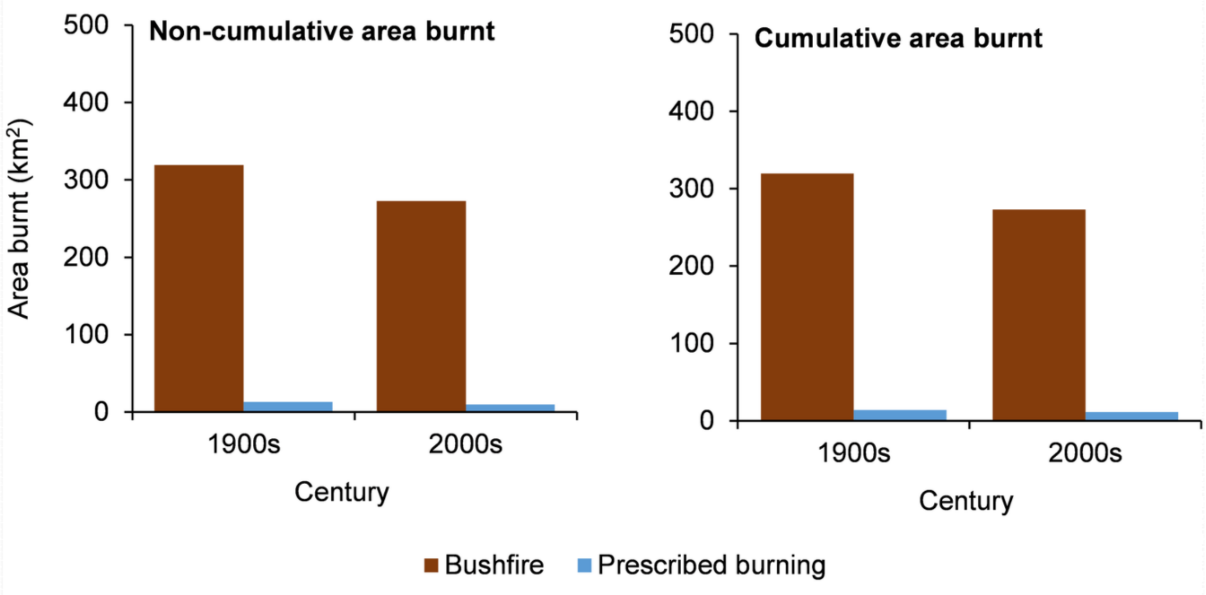
Subregion: Highlands - Southern Fall *(Total area = 11,956km², 64% in GKLaWAC)*



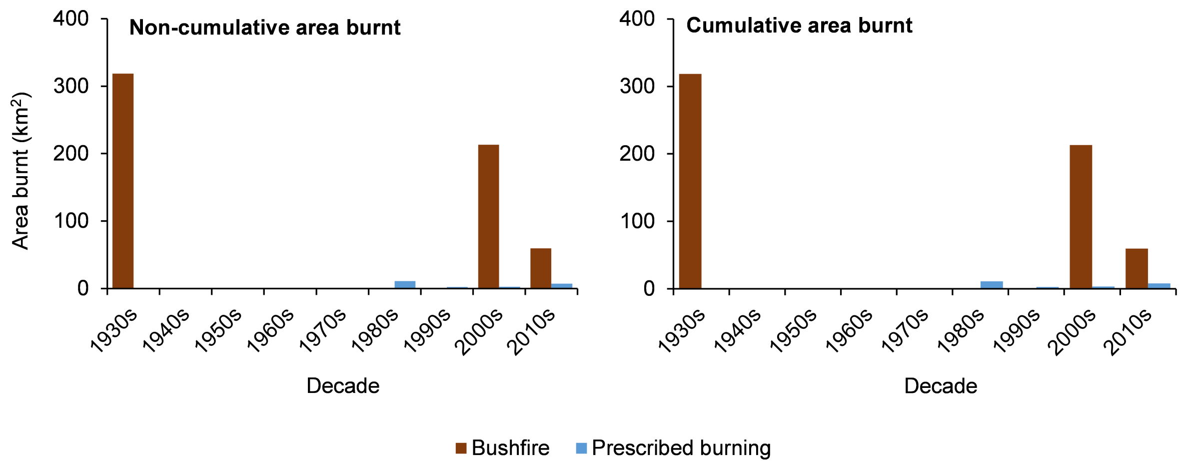


Strzelecki Ranges.

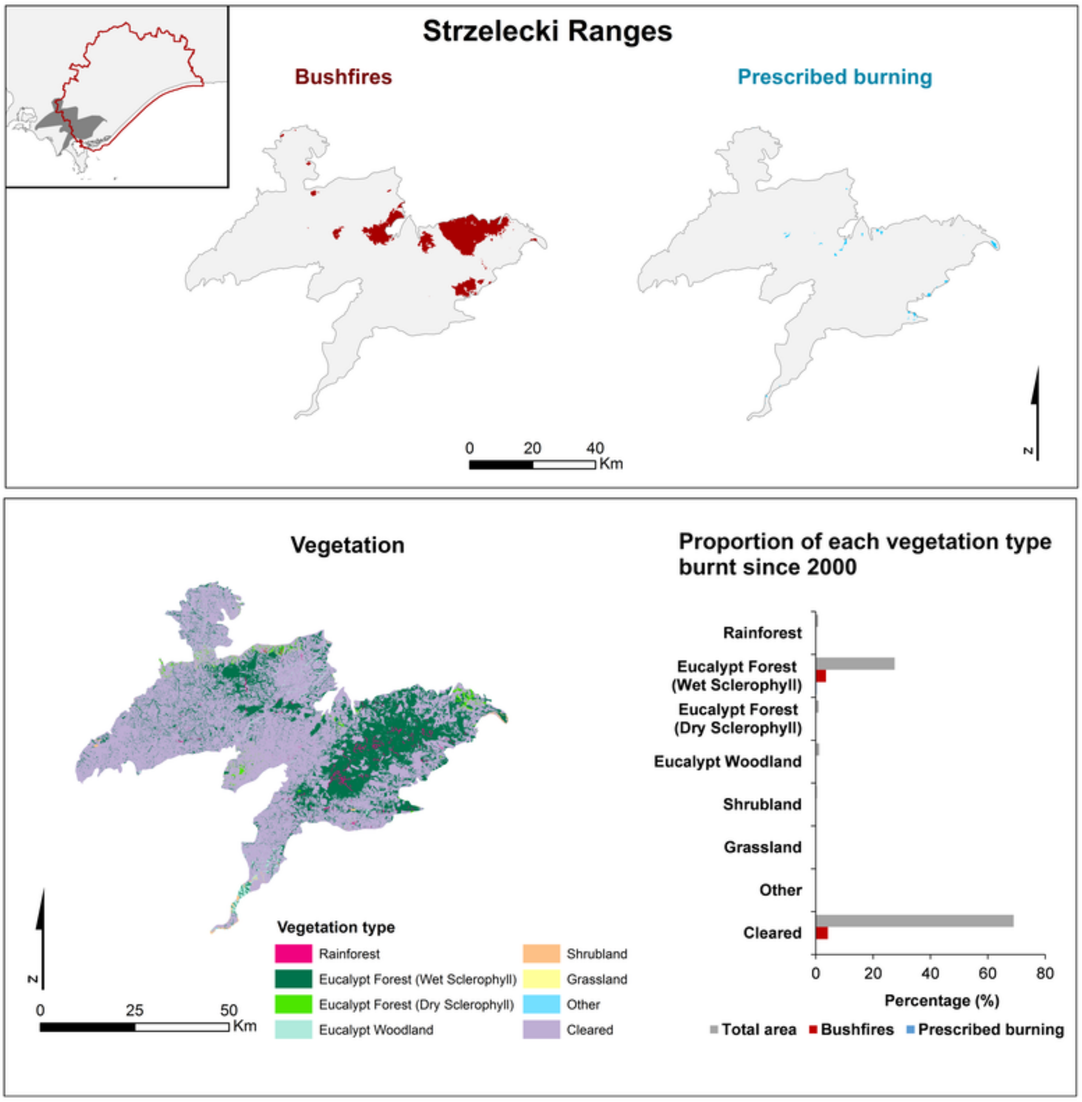
Subregion: Strezlecki Ranges *(Total area = 3,418km^2, 57% in GKLaWAC)*



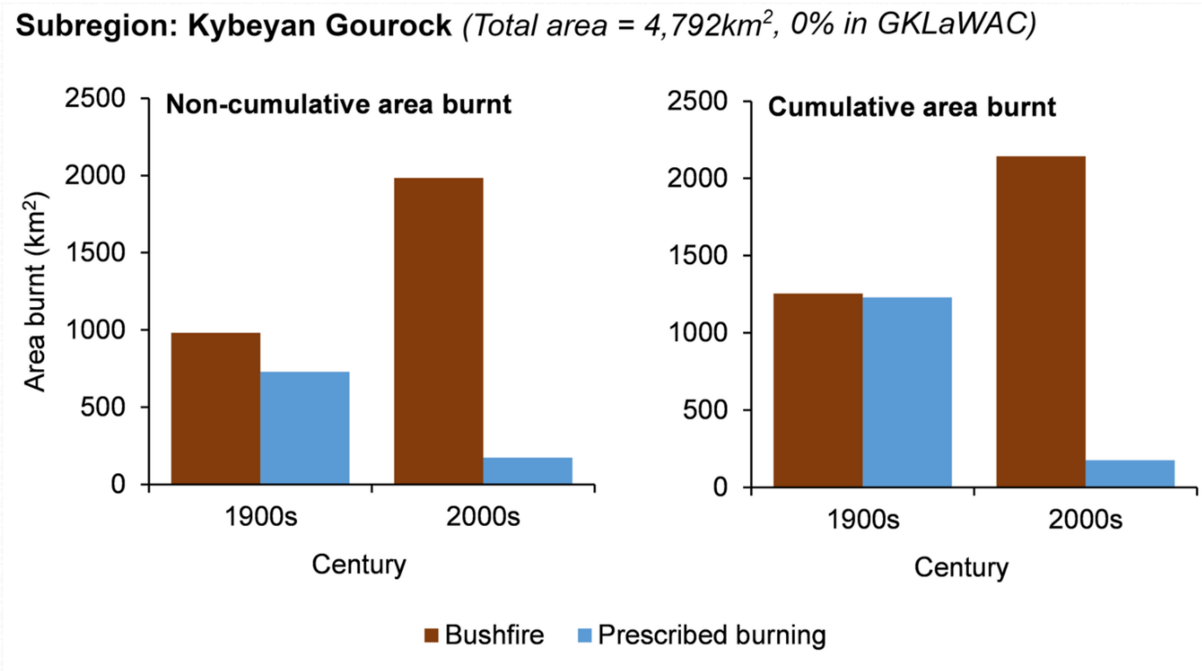
Subregion: Strezlecki Ranges *(Total area = 3,418km^2, 57% in GKLaWAC)*

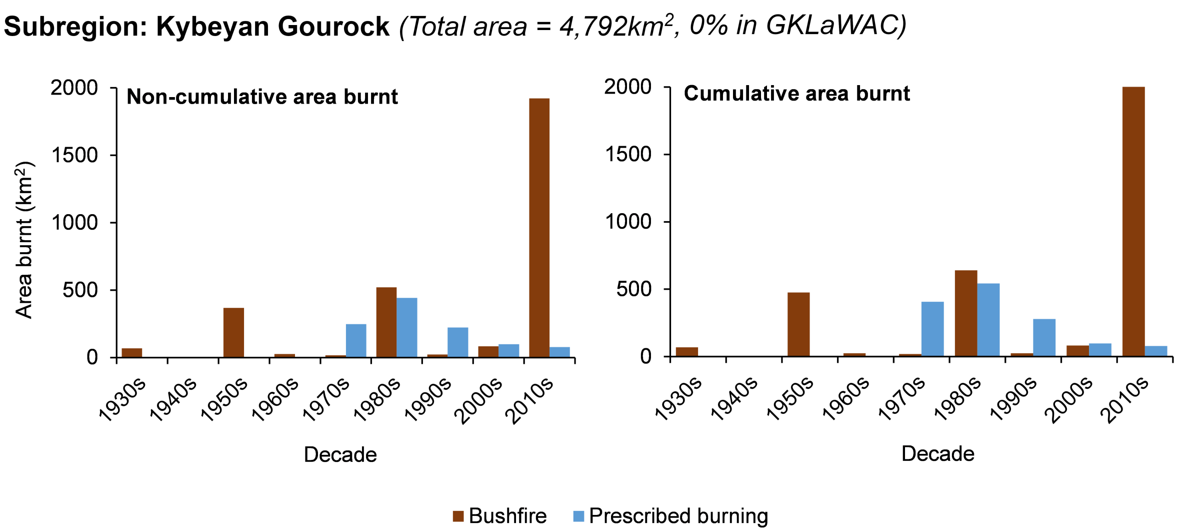


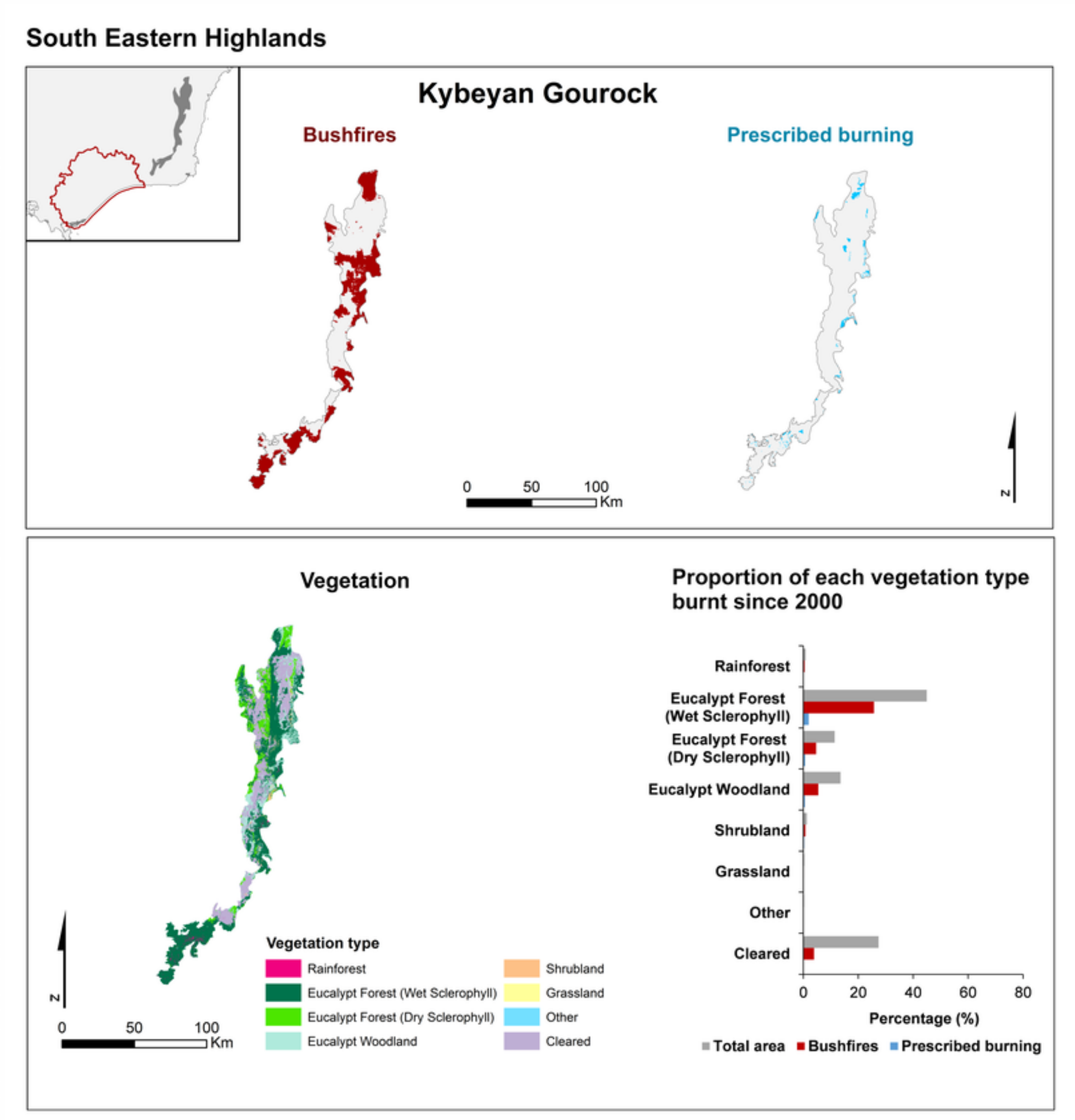
South Eastern Highlands



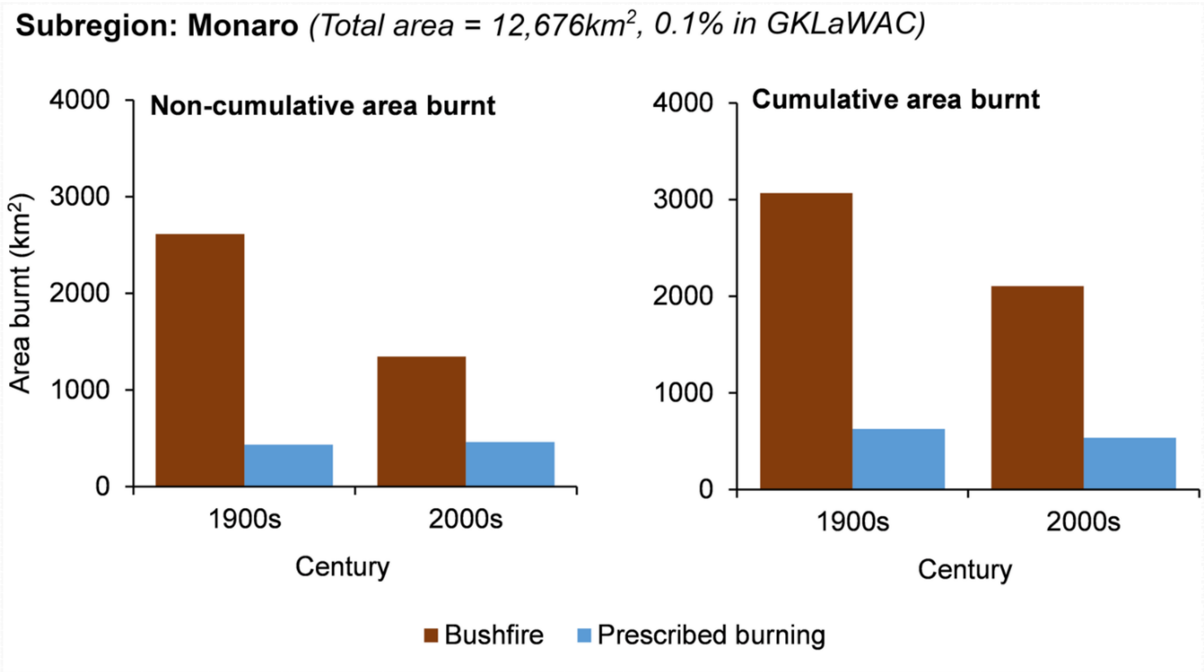
Kybeyan Gourock.

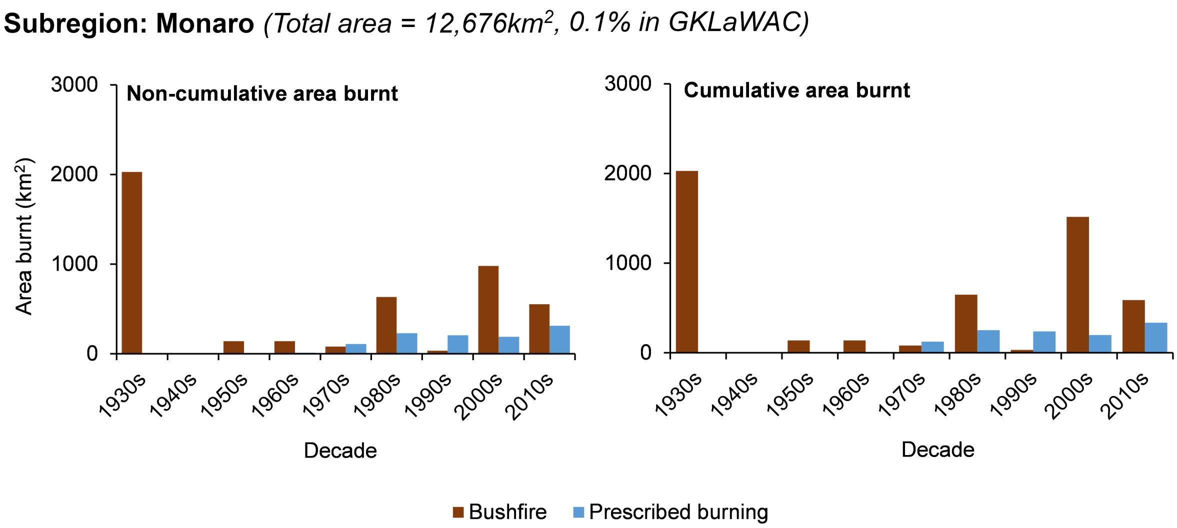

Subregion: Kybeyan Gourock (Total area = 4,792km2, 0% in GKLaWAC)
Non-cumulative area burnt
Cumulative area burnt
Area burnt (km2)
2500
2000
1500
1000
500
0
1900s
2000s
Century
Bushfire
Prescribed burning


Subregion: Kybeyan Gourock (Total area = 4,792km2, 0% in GKLaWAC)
Non-cumulative area burnt
Cumulative area burnt
Area burnt (km2)
2000
1500
1000
500
0
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s
2010s
Decade
Bushfire
Prescribed burning

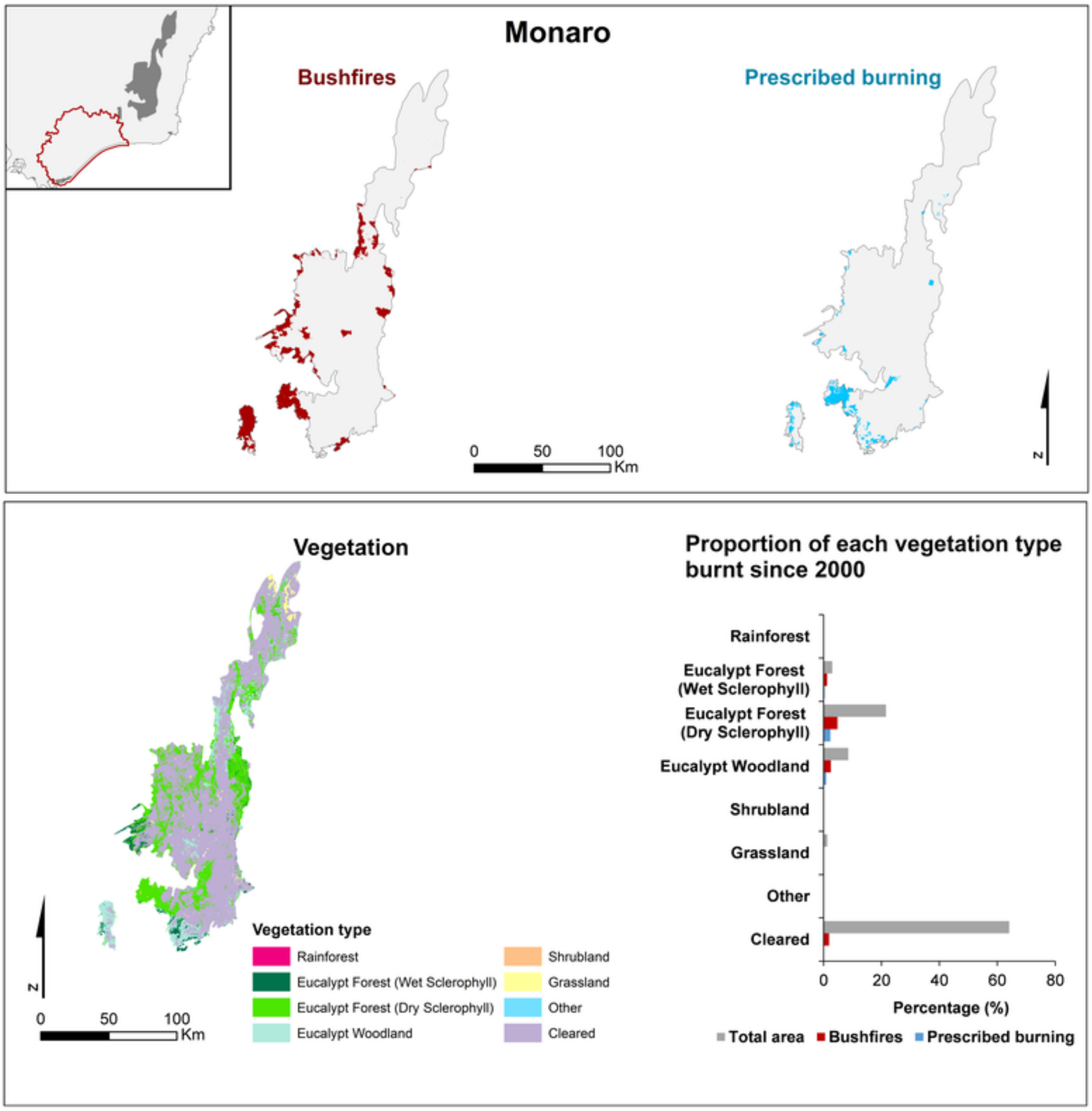

South Eastern Highlands
Kybeyan Gourock
Bushfires
Prescribed burning
0 50 100 Km
N
Vegetation
Proportion of each vegetation type burnt since 2000
Rainforest
Eucalypt Forest (Wet Sclerophyll)
Eucalypt Forest (Dry Sclerophyll)
Eucalypt Woodland
Shrubland
Grassland
Other
Cleared
0 20 40 60 80
Percentage (%)
Total area
Bushfires
Prescribed burning
Vegetation type
Rainforest
Eucalypt Forest (Wet Sclerophyll)
Eucalypt Forest (Dry Sclerophyll)
Eucalypt Woodland
Shrubland
Grassland
Other
Cleared

Monaro.

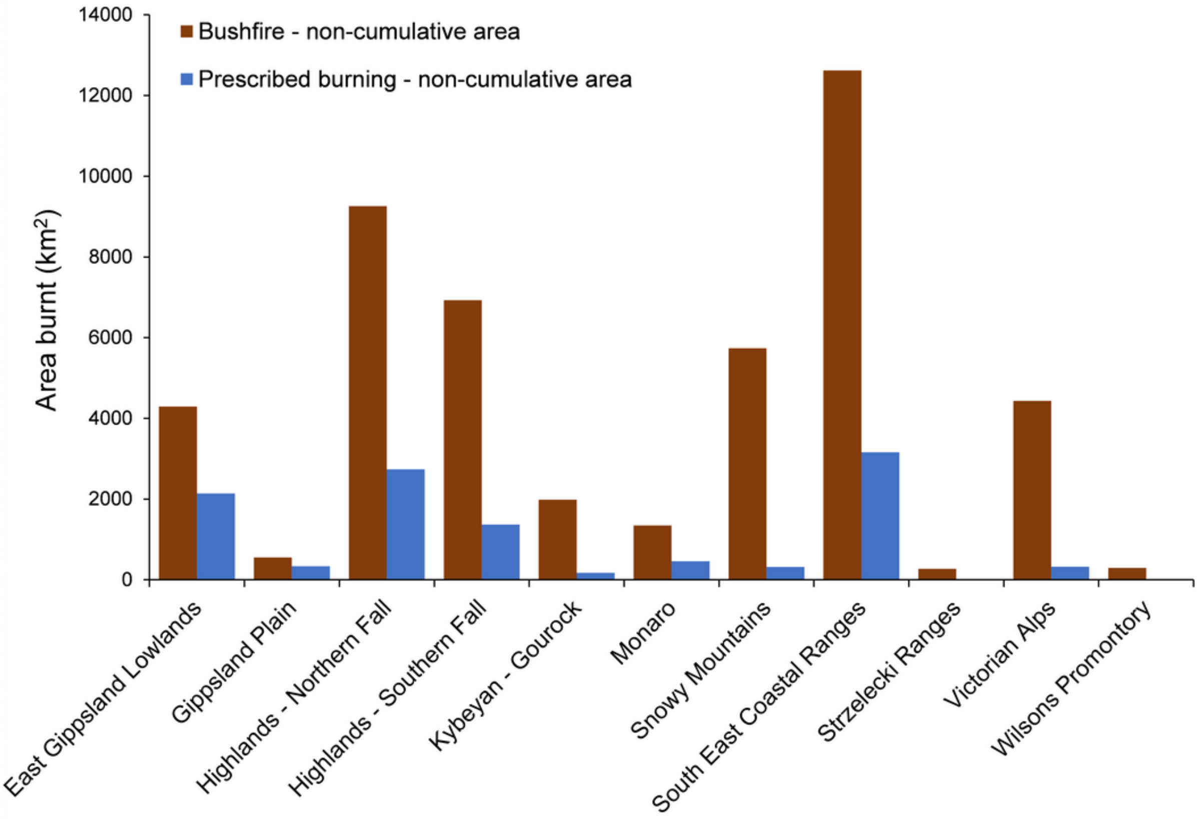

Subregion: Monaro (Total area = 12,676km2, 0.1% in GKLaWAC)
Non-cumulative area burnt
Cumulative area burnt
Area burnt (km2)
4000
3000
2000
1000
0
1900s
2000s
Century
Bushfire
Prescribed burning


Subregion: Monaro (Total area = 12,676km2, 0.1% in GKLaWAC)
Non-cumulative area burnt
Cumulative area burnt
Area burnt (km2)
3000
2000
1000
0
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s
2010s
Decade
Bushfire
Prescribed burning

South Eastern Highlands



Non-cumulative area burnt in each subregion by bushfire and prescribed burning since the year 2000



15. The Interplay between Fire, Landscape and Cultural Sites in GunaiKurnai Country

By Jessie Buettel, Bruno David, Joanna Fresløv and Russell Mullett

...

16. Fire Management in GunaiKurnai Country: Actualities, Practices and Aspirations

By Russell Mullett, Bruno David, Joanna Fresløv and Jessie Buettel

…

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