Live fast DIE YOUNG

Fire ephemerals and their conservation management

by Dr Carl Gosper, Bree Phillips, Megan Dilly and Dr Tanya Llorens

Careful observers of the Australian bush may have noticed that, following fires, there are often more plant species present in the live vegetation than there were beforehand. Some of these newly appeared species recruit from seeds stored in the soil and can initially be abundant, yet disappear after a few years, only to reappear later after another fire. These species are known as fire ephemerals.

Fire ephemerals thrive in the post-fire environment and persist as seeds in the soil for decades to centuries between fires. These specific adaptations create unique opportunities and challenges for their conservation management.

Most terrestrial plant species in Western Australia have traits that allow them to persist through fires, either as individuals or populations. These traits have been shaped by evolution in a landscape with recurrent fires over millions of years.

Fire ephemerals are plant species whose germination is strongly driven by fire, often germinating after fires en masse, and which then rapidly grow and complete their life cycle of flowering and setting seed in one to a few years after fire. They then disappear from the above-ground vegetation for the bulk of the period between fires, existing as a long-lived soil-stored seed bank.

This fire response strategy allows fire ephemerals to take advantage of lower competition with other plants for light, water and nutrients shortly after fires.

Adaptations for the fire ephemeral strategy include a highly persistent, soil-stored seed bank that potentially retains viability over decades to centuries between fires; seed dormancy mechanisms that are broken by fire cues (usually heat and/or smoke, often in combination with in situ weathering in the soil) allowing germination to be timed to post-fire conditions; rapid growth; and early flowering and seeding.

Fire ephemerals occur in many ecosystems across WA, from deserts to woodlands, heathlands and forests. They are often most noticed in ecosystems and locations that burn infrequently, either due to natural features or anthropogenic landscape changes.

Opposite page
Top Glandular raspwort (*Haloragodendron glandulosum*).
Photo – Rob Davis/DBCA
Inset far left Prescribed burn at Mollerin Nature Reserve.
Photo – Laurent Marsol/DBCA
Inset left Newly-germinated net-veined Gyrostemon (*Gyrostemon reticulatus*) after a prescribed burn at Mollerin Nature Reserve.
Photo – Bree Phillips/DBCA
Background Soil; bushfire flames.
Photos – Klikk; Sebastian/Adobe

Inset above Fire ephemerals recorded after the Two Peoples Bay Nature Reserve bushfire. The Vulnerable Northcliff Kennedia (*Kennedia glabrata*).
Photo – Megan Dilly

Above right and opposite page far left *Gyrostemon reticulatus* seeds.
Photo – Andrew Crawford/DBCA

Fire ephemerals

Fire ephemerals range in growth form from herbs, grasses and groundcovers to shrubs and small trees, and occur across diverse plant lineages. Examples include:

Family	Species	Common name
Gyrostemonaceae	*Codonocarpus cotinifolius*	Native poplar
Solanaceae	*Anthocercis littorea*	Yellow tailflower
Macarthuriaceae	*Macarthuria keigheryi*	
Araliaceae	*Hydrocotyle phoenix*	Fire pennywort
Apiaceae	*Actinotus leucocephalus*	Flannel flower
Poaceae	*Austrostipa compressa*	Speargrass
Malvaceae	*Alyogyne hakeifolia*	Native hibiscus

Top *Macarthuria australis*.
Photo – Eddy Wajon/Sallyanne Cousans Photography

Top right Post-fire flush of flowering of annuals and fire ephemerals after a prescribed burn in Mollerin Nature Reserve.
Photo – Bree Phillips

Above Native grass *Austrostipa compressa* flourishing after a recent fire.
Photo – Eddy Wajon/Sallyanne Cousans Photography

Opposite page
Left DBCA Wheatbelt staff using a flamethrower to ignite a prescribed burn at Mollerin Nature Reserve that led to substantial recruitment of the Critically Endangered fire ephemeral *Gyrostemon reticulatus*.
Photo – Laurent Marsol/DBCA
Far right Critically Endangered *Gyrostemon reticulatus* that germinated en masse after a prescribed burn in Mollerin Nature Reserve.
Photo – Bree Phillips/DBCA
Inset right *Gyrostemon reticulatus*.
Photo – Andrew Crawford/DBCA

OPPORTUNITIES AND CHALLENGES IN CONSERVATION MANAGEMENT

The unique ecology of fire ephemerals offers opportunities and challenges for their conservation management in the context of fire events, primarily through their limited lifespan as mature plants but long persistence, often undetected or unquantified, in the soil-stored seed bank.

The transient nature of adult plants presents a time-limited opportunity for conservation actions involving live plants. Monitoring of population size and extent, ecological study or observation, or conservation seed collection (such as for banking at the Western Australian Seed Centre) is only practical within a few years post-fire before the species retreats to the soil-stored seed bank.

Seed banks with putatively considerable longevity and strong responses to fire stimuli provide opportunities for the use of prescribed burns to recover live plant populations of fire ephemerals, even where mature plants have long been absent. Therefore, prescribed burns and bushfires can lead to unexpected discoveries of fire ephemerals.

Nevertheless, conservation managers face complex decisions over where, when and how frequently it may be desirable to use fire to stimulate recruitment in fire ephemerals, compounded by gaps in knowledge of the seed bank ecology of many species.

CONSERVATION ASSESSMENT OF FIRE EPHEMERALS

Listing a species of conservation concern as threatened under the *Biodiversity Conservation Act 2016* provides greater legislative protection and a focus for conservation management.

To qualify for listing, however, it first must be established that the species has been adequately surveyed. The global standard IUCN (International Union for Conservation of Nature) Red List criteria are then used to quantify scientific metrics relating to population size reduction, restricted geographic range and small population size and decline.

Compiling this information can be particularly difficult for fire ephemerals that occur in landscapes with very low fire frequencies, most notably WA's Wheatbelt, where countless species-rich but highly fragmented vegetation

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Planned population recovery of Gyrostemon reticulatus *through prescribed burning*

Gyrostemon is a genus of fire ephemerals with 14 species in Western Australia. Four of these are recognised by the Department of Biodiversity, Conservation and Attractions (DBCA) as data deficient, meaning they have insufficient population information to robustly assess their conservation status. A further species, net-veined Gyrostemon (*Gyrostemon reticulatus*) is Critically Endangered.

Historically known from less than 10 scattered locations across the northern Wheatbelt, *G. reticulatus* was once thought extinct, having not been recorded between 1938 and 1990. However, even if this species was not present in the above-ground vegetation over this period (although that cannot be known), it clearly remained extant as persistent seeds in the seed bank, from which above-ground plants intermittently emerged after fire.

Gyrostemon reticulatus is threatened because of extensive vegetation clearance for agriculture leading to fragmentation of populations across its small range, and continuing decline in habitat quality.

The rarity of fire in Wheatbelt remnants over recent decades, due to disrupted patterns of fire ignition and spread combined with fire suppression efforts, has likely contributed to the paucity of recent records.

In 1999, a single collection of *G. reticulatus* was made by Greg Keighery in Mollerin Nature Reserve in the northern Wheatbelt and lodged with the Western Australian Herbarium, yet no plants had subsequently been recorded at this site. The herbarium record suggested that the area had burnt shortly prior to collection.

In autumn 2019, DBCA Wheatbelt Region planned a small, 12-hectare burn within the vicinity of the population that aimed to stimulate recruitment from soil-stored seed and determine the accuracy of the population location.

Scrub rolling was used as a tool to increase fuel availability in the burn area to ensure the heat pulse from the burn was high enough to trigger germination. Interestingly, the scrub rolling resulted in some germination of *G. reticulatus* prior to the burn.

The germination requirements of this species are complex and poorly understood, however it is thought that seed dormancy is physiological with seasonal dormancy cycling and requires an after-ripening period.

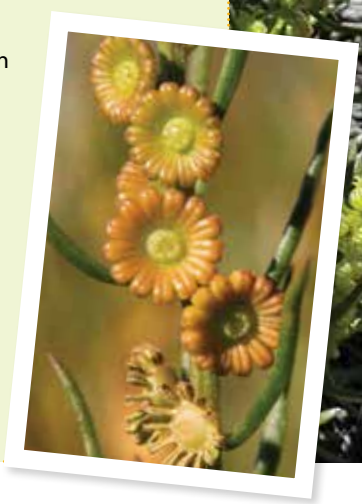
The burn was delayed due to the germination, however the plants followed the typical 'live fast, die young' strategy of fire ephemerals by growing quickly, reproducing and senescing within a few years of germination. As a result, part of the burn was successfully undertaken in autumn 2022.

The burn resulted in the mass germination of *G. reticulatus*, with the population currently estimated as approximately 50,000 mature and 11,000 juvenile individuals, replenishing the soil-stored seed bank through survival of plants through to reproductive maturity.

This outcome was a great success in itself, but it also allowed DBCA to survey the population, map the boundary, and collect seed for long-term storage at the Western Australian Seed Centre in Kensington, potentially for use in future conservation actions.

The successful burn paved the way for further burns to be undertaken in adjacent suitable habitat in Mollerin Nature Reserve and possibly other areas of remnant vegetation to determine the true extent of distribution of this species.

More broadly, DBCA is undertaking prescribed burns across a range of Wheatbelt nature reserves to address vegetation senescence arising through the widespread long-term absence of fire. These burns are initiating recruitment of fire ephemerals and other plant species and in doing so are contributing to maintaining the Wheatbelt's extraordinary plant diversity.



Surprise discovery of a new Hydrocotyle *species after bushfire*

In 2015, bushfires caused by dry thunderstorms affected all of Megan Dilly's Master's research sites.

While she considered the consequences for her research, she explored the freshly burnt areas with her supervisors, Professor Steve Hopper (UWA) and Sarah Barrett (Conservation Officer - Flora, Albany District DBCA), to document the flora.

A site at Two Peoples Bay Nature Reserve had been actively managed to exclude fire for the conservation of threatened fauna and had not burned in the 70 plus years records had been kept, other than a few previous lightning ignitions that were contained to small areas. Along with the post-fire flush of flowering expected after a fire and a profusion of annuals, the group also recorded several interesting fire ephemerals, such as the Northcliffe Kennedia (*Kennedia glabrata*), a Vulnerable (threatened) species, almost 100 kilometres east of its previously known range.

They also discovered an unusual pennywort (*Hydrocotyle*) species none of the three recognised that had germinated in only two very localised areas in gullies, one in Torndirrup National Park and the other in Two Peoples Bay. It did not match any published material, nor did it match any specimens at the Western Australian Herbarium.

Neither consultant botanist Libby Sandiford nor Mike Hislop of the Western Australian Herbarium could identify it, confirming it was something unknown. They sent the specimen to the Araliaceae expert Andrew Perkins at the Western Australian Herbarium who declared it to be an undescribed *Hydrocotyle* species (later named as *H. serendipita*).

The genus *Hydrocotyle* is mostly perennial but includes some annual species. All 35 annual species occur in Australia with 28 occurring in the south-west of Western Australia. Many of these annual species are ephemeral, growing for a few months of the year following good rains.

However, no fire ephemeral species had been known to occur in *Hydrocotyle* until the year before this new discovery, when in 2014 an undescribed species was discovered by Rob Davis of the Western Australia Herbarium in recently-burnt forests near Northcliffe.

This species was named as *H. phoenix*, as it rose from the ashes and appeared to be closely related to *H. serendipita*. Both *H. phoenix* and *H. serendipita* are regarded as data deficient by DBCA.

Both these fire ephemeral *Hydrocotyle* are very short-lived and appear very restricted in range, so their chance discovery was indeed lucky. With only a short timeframe to document and assess *H. serendipita*, in another stroke of luck, Dr Anne Cochrane from the Western Australian Seed Centre in Kensington was present when *H. serendipita* was discovered at Two Peoples Bay and was able to collect seed before it disappeared from the above-ground flora back into the seedbank.

Inset above Fire ephemerals recorded after the Two Peoples Bay Nature Reserve bushfire—the previously unknown *Hydrocotyle serendipita*, now regarded as data deficient.

Left Green shoots of resprouting plants emerging after a bushfire swept through the heathland of Two Peoples Bay Nature Reserve.
Photos – Megan Dilly

Top Megan Dilly conducting fieldwork at Two Peoples Bay Nature Reserve.
Photo – Sarah Barrett/DBCA

Above Yellow tailflower (*Anthocercis littorea*).
Photo – Marie Lochman

remnants have remained unburnt for many decades.

Some challenges can include conducting a census of the number of mature individuals and decline over time if the presence of live plants is highly unsynchronised across populations; distinguishing population declines driven by threats from natural fluctuations; determining whether a long-unseen population can be considered extinct; assessing geographic range; and assessing threats to live plants when the plants are rarely seen.

Similar challenges are encountered when assessing whether a fire ephemeral species is eligible for listing as extinct under the Biodiversity Conservation Act—how long is it reasonable to wait after the plant was last seen?

Similarly, fire ephemerals listed as threatened or listed by the Department of Biodiversity, Conservation and Attractions (DBCA) as priority flora can require special consideration during the Environmental Impact Assessment process when identifying risks posed to the species by a proposed development or action.

Field surveys and existing records can often not be relied upon to reveal a fire ephemeral's presence at a long-unburnt site, and knowledge of its biology and ecology may be lacking. It is therefore necessary to use the precautionary principle, take a case-by-case approach and carefully weigh the best scientific information available to assess the likelihood that the species is present at a site, the population's probable size and extent, and how important the population is to the species as a whole.

If a fire ephemeral is thought to possess long-lived seeds and has previously been recorded at a site, it is usually assumed that the population still persists within the soil seedbank. This is true even if it has not been seen for decades, providing the habitat has not been significantly altered or degraded through too-frequent fire or disturbance.

If a fire ephemeral has not been recorded previously from a long-unburnt site, knowledge of its geographic distribution and habitat preferences are key. Occurrence can be more easily and accurately predicted for species that are restricted, both geographically and to a specialised habitat type, compared with those with a less specific (or unknown) habitat preference, which pose additional challenges.

Above left Flannel flowers (*Actinotus leucocephalus*).
Photo – Simon Cherriman

Above Lilac hibiscus (*Alygone huegelii*).
Photo – Sallyanne Cousans

Inset above *Androcalva adenothalia.*
Photo – Rob Davis/DBCA

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