Science for Saving Species

Research findings factsheet

Project 1.3.1

Threatened Species Recovery Hub

National Environmental Science Programme

Fire-adapted traits of threatened *Pomaderris* shrub species in riparian refugia: Implications for fire regime management

In brief

Australian plant species can require particular seasons, intensities or frequencies of burns to maintain healthy populations. It is important for conservation managers to understanding the fire needs and tolerances of plant species they are seeking to conserve.

We undertook research to fill knowledge gaps about the fire needs of three threatened species of native *Pomaderris* shrub: *P. adnata, P. bodalla* and *P. walshii*. We found that high temperatures typical of higher severity fire maximised the germination of each species, without reducing the viability of seeds. All species also had persistent soil seed banks.

These *Pomaderris* species principally occur in riparian zones, which typically experience less fire than surrounding areas and often feature plants that are less adapted to fire.

We recommend that a regime involving occasional higher-severity fires, combined with long non-fire intervals, will benefit the long-lived *Pomaderris* populations while minimising impacts on the broader riparian ecosystems.

Background

Threats such as invasive species, land clearing, habitat degradation and changed fire regimes have resulted in major contractions in the ranges of many threatened plant species. Continuing declines of some threatened plant populations can be due to a lack of an appropriate fire regime.

Conserving threatened plant species in fire-prone habitats requires an understanding of their fire adaptation strategies. This includes identifying any specific requirements that a species may have regarding fire season, intensity, or frequency in order to recruit new plants. Without the required fire conditions, seeds of some species will not germinate reducing their ability to regenerate and persist. Knowledge of the specific fire needs and tolerances of many threatened species is lacking.

Establishing an ideal fire regime is further complicated when plants with different fire needs and sensitivity co-occur. For example, the fire pattern needed by some species to persist long-term would kill other species. Over long time-frames in natural settings plants shift and evolve to suit the prevailing conditions; however, much has changed in the past 200 years, including the fire patterns across many regions.

Riparian zones along waterways typically experience less fire than surrounding areas, due to a more humid, moist microclimate with slower drying rates of leaf litter and fuels. As such, they can be fire refugia. These areas often have a variety of plant species that are not adapted or are poorly adapted to fire, for example, they may not need fire to germinate and fire may kill them.

Our research is filling knowledge gaps to support conservation managers to protect three species of threatened Pomaderris, a large, relatively long-lived (+25 years) native shrub. This includes the three species *P. adnata, P. bodalla* and *P. walshii*.

Pomaderris are generally fire-adapted, but in a surprising twist these three species now primarily only occur within riparian fire-refuge sites. It was unknown if the lack of fire at these sites contributed to their persistence at these sites, or if they persisted in spite of it. Conservation managers did not know if sites should be burnt or protected from fire and, if burnt, what particular fire regime should be adopted.

Poorly known species may be at particular risk of having unsuitable fire regimes applied to them, if they are managed under scenarios that are based on the broader vegetation types in the adjacent landscape.

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Research aims

We aimed to understand the fire needs of the three selected *Pomaderris* species, including whether they have life-history traits that respond to fire cues, such as a need for heat shock for germination.

Further, we sought to understand how the current distribution of these species relates to the prevailing fire regimes in the riparian areas where they are found.

In filling these gaps, we hoped to address the main question for managers, namely, whether these refugia should be burnt or protected from fire in order to enable the threatened species to persist and, if so, how to inform prescribed burning for their persistence.

What we did

We set out to conduct an experimental assessment of key *Pomaderris* species life-history traits and how much they depend on fire. To do this, we first collected seeds from populations of the three Pomaderris species, currently found on the south coast of New South Wales in locations stretching from the Eurobodalla region north to the Illawarra.

We treated the seeds at a range of hot temperatures (from 60°C to 120°C) in germination trials. Temperatures at the higher end of this range are found in the soil only under conditions of fire, so germination after such heat-shock would indicate that the species needs fire to germinate.

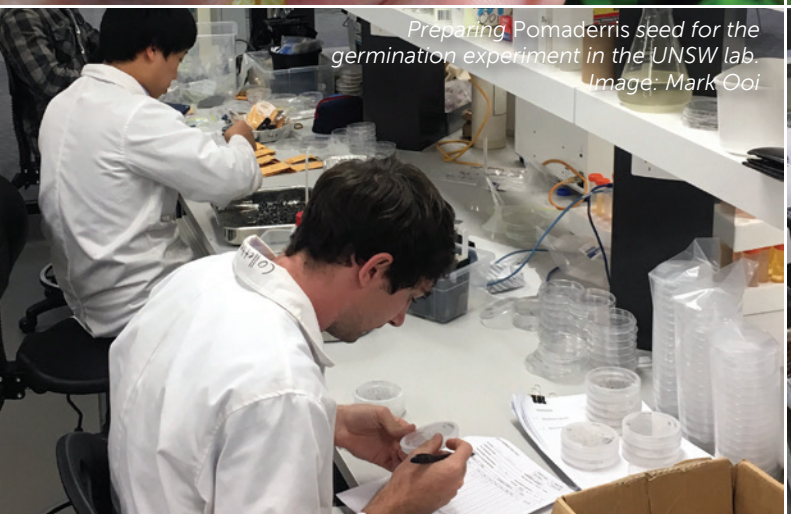
We also simulated small-scale fires on soil samples in a furnace, to test for the presence of a soil-stored seed bank that responds to fire.

Finally, we conducted surveys in the field after fires to examine seedling emergence following fires.

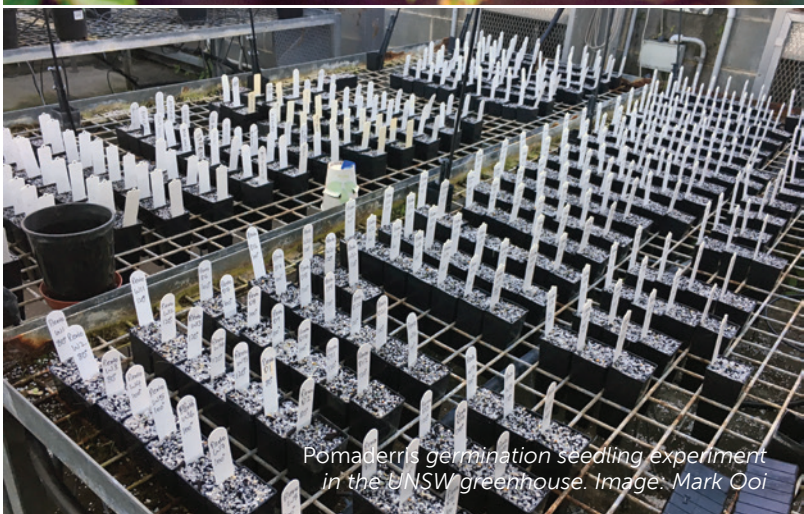
This research received the assistance of the New South Wales Office of Environment and Heritage (now the Department of Planning Industry and Environment). Field and laboratory work was carried out between 2015 and 2018 by two University of Wollongong students (Tom Le Breton and Sophie Natale), under the supervision of Mark Ooi, Ben Gooden and Kris French.

Pomaderris walshii.
Image: Jedda Lemmon, DPIE, Saving our Species

Pomaderris adnata.
Image: Jedda Lemmon, DPIE, Saving our Species



Preparing Pomaderris *seed for the germination experiment in the UNSW lab. Image: Mark Ooi*



Pomaderris germination seedling experiment in the UNSW greenhouse. Image: Mark Ooi

Key findings

Our key finding was that all three *Pomaderris* species had a high temperature requirement to break seed dormancy and promote germination.

We also found that seedling emergence was higher in areas where fire had been through. This means that for all three of the study species, fire is important to recruitment, regeneration and persistence.

Maximum germination for the three threatened *Pomaderris* species occurred in response to 100°C temperatures typical of higher-severity fires. There was some variation between the species, with *P. bodalla* most dependent on high intensity fires and showing very little germination at lower temperatures. *P. adnata* and *P. walshii* also had maximum response at 100°C but could also germinate at lower fire-related temperatures.

The three species also responded positively to high temperatures when we heated the soil seed bank with temperatures consistent with fire. In addition, mature *P. adnata* individuals were observed to be capable of post-fire resprouting and survival. Taken together, this evidence strongly suggests that the Pomaderris species are adapted to fire, specifically higher-intensity fires.

The observations in this study of *P. adnata* sprouting post-fire are the first for the species, which was previously assumed to be killed by fire. However, we found that the more intense the burn to the canopy, the less likely individuals were to sprout in the first year and to survive into the third year post-fire. This suggests that resprouting is likely to only occur in response to lower-severity fires that leave the canopy partially intact. During higher severity fires, *P. adnata* may rely on its soil-stored seed bank for persistence. Resprouting in *P. adnata* might carry the bet-hedging advantage of allowing the persistence of the standing population during low-severity fires that don't generate high enough temperatures to promote significant germination.

Of the three species, *P. walshii* showed a germination response across the widest range of temperatures we tested. It is also the species most closely associated with the riparian zone, with its higher levels of soil moisture. For this species, germination may therefore be enabled under patchier soil heating during fire, or it may be able to recruit into gaps formed during other kinds of habitat disturbance as well.

These results are somewhat counterintuitive from a management perspective for species that predominantly occur in the riparian zone, as this is an area that land managers traditionally protect from high severity fires, providing instead regimes typically of low frequency, low severity fires. Our results clearly show that germination for each of the three *Pomaderris* species investigated is maximised by higher temperature related to hotter fires.

However, we also found evidence that these species have bet-hedging strategies that allow for some recruitment under alternative fire regimes, including in an absence of fire.

Previous work has shown that germination in the periods between fires can reduce the overall species populations, because it reduces the seed bank and, further, young plants are killed by returning fire before they reach reproductive maturity. However, in the riparian zone, with lower frequency fires and more moisture available, more germination may help maintain the population, even if this is at lower levels than would be expected with fire. This is a bet-hedging strategy that may also help explain why the study species have been able to persist in the riparian zone in the absence of fire.

The life-history traits of the species suggest that infrequent high severity fires are a fire regime these species are adapted to; however, the retreat to riparian zones indicates that for these species little to no fire is preferable to frequent low-intensity fires. Such a fire regime would limit both the time available for seedlings to mature and germination of the non-dormant fraction of the seed bank.

Notably, the higher-frequency, lower-intensity fire pattern may have become more common since European settlement, as part of the management of the areas where these *Pomaderris* species occur (i.e., state forests and national parks). It may well be the case that these species are persisting in such refugia not because the riparian zone necessarily possesses the most favourable fire regime, but because the fire regime of the broader landscape has become unsuitable.

Implications

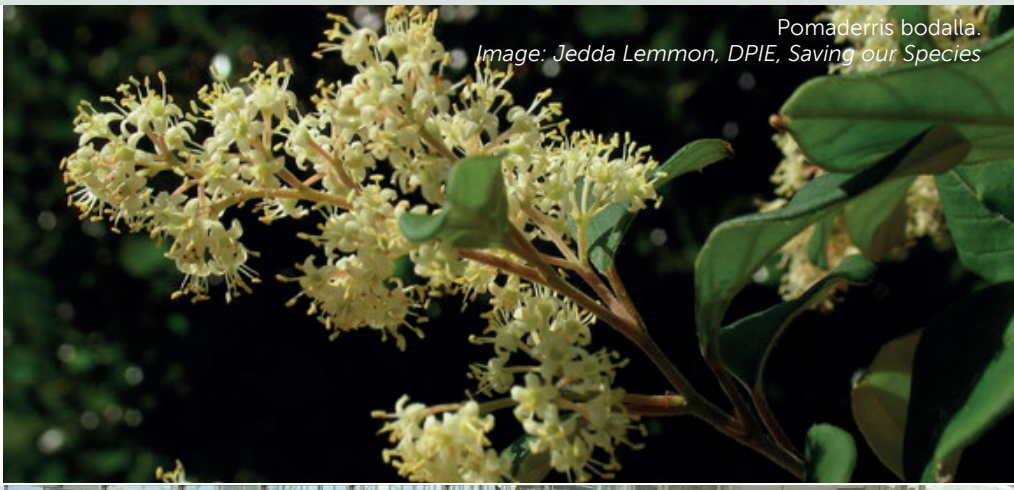
The different bet-hedging mechanisms possessed by the study species of *Pomaderris* may enable their persistence during long intervals between fires. However, a higher severity fire that promotes the germination of the *Pomaderris* species, followed by a longer fire interval allowing for the requirements of the other non-fire adapted riparian vegetation, may represent a suitable compromise for managers seeking to maximise threatened species populations while minimising non-target impacts on the broader riparian ecosystem.

For threatened species management, it is crucial to understand the mechanisms influencing the distribution of the plant species, to allow them to expand beyond isolated surviving populations and secure their futures. For such species, while the immediate priority may be securing existing populations, the fire regime they prefer and how best to manage for that should be considered at multiple scales.

Implementing a favourable fire regime where the species still occurs may promote its persistence and the growth of its populations. However, if this fire regime remains absent from the broader landscape, then the species will struggle to recolonise those areas and will remain restricted to fire refugia, which may not be a viable situation over the long term.

Cited material

Le Breton T.D., Natale S., French K., Gooden B., Ooi M.K.J. (2020) Fire-adapted traits of threatened shrub species in riparian refugia: implications for fire regime management. *Plant Ecology* 221, 69-81.



Pomaderris bodalla.
Image: Jedda Lemmon, DPIE, Saving our Species

Further Information

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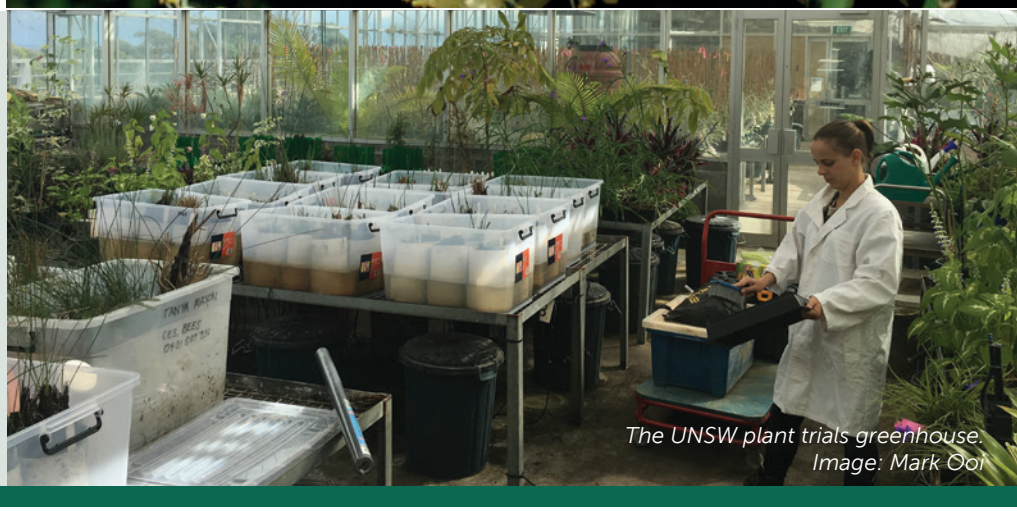

The UNSW plant trials greenhouse.
Image: Mark Ooi

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