

How small mammals respond to fire: The case of dasyurids

In brief

Dasyurids are a family of carnivorous marsupials that includes dunnarts, quolls, the Tasmanian devil, antechinuses, ningauis, planigales and phascogales. Australia has 64 species of dasyurid, many of which are declining and listed as threatened.

Excessively frequent bushfires are suspected to negatively affect many dasyurid species. Conservation managers need guidance on different species' sensitivity to fire and how to minimise negative impacts on populations.

Our research found that dasyurid species that only breed once per year or once in their lifetime experience the most severe declines after fire. Forest dwelling species are also more negatively impacted by fire than arid zone species.

Fire management strategies should aim for low intensity burns that do not reach the canopy and that leave unburnt habitat patches, timed to avoid the time of year when vulnerable young are in the nest and when they are learning to hunt for themselves (in annual-breeding species this is early summer).

Background

Australian mammals have suffered widespread declines since European arrival. Declines are ongoing; over the past two decades populations of threatened Australian mammals have declined by more than one third (38%) on average. Smaller mammals have been particularly impacted.

Many small mammals prefer dense vegetation for the cover it provides for nesting and for protection against predators. Denser vegetation and deep leaf litter may also provide more food for insectivorous species. Fire reduces the amount of vegetation available.

Inappropriate fire regimes have been linked to population declines, and climate change is likely to hasten declines by increasing the frequency and severity of wildfires. Population declines can lead to reductions in ranges and genetic diversity which exacerbate declines.

Small mammals are generally unable to outrun fires, although individuals may survive in unburnt refuges and under non-flammable insulating cover such as rocks in affected areas. Life history traits strongly influence whether the population of surviving individuals will rebound or decline after fire.



Antechinus flavipes. Image: Diana Fisher



Background (continued)

These traits include: lifespan; age at maturity; timing and frequency of breeding, and number of young. Other traits can also be important, especially how far and fast the species can move; body size and use of torpor which affect ability to go without food temporarily.

Dasyurids are carnivorous marsupials. Most of them are small mammals- the Tasmanian devil is the largest extant dasyurid. They include dunnarts, quolls, ningauis and antechinuses. Their diet includes a wide range of small animals such as insects, spiders, other invertebrates, and small lizards and rodents.

They also live in a wide range of habitat types from the arid zone to montane forests and alpine areas.

Many of Australia's 64 dasyurid species are declining, and over half of the species from northern Australia are classified as extinct, threatened or near threatened.

Dasyurids have a range of breeding strategies. Some breed multiple times per year and per lifespan, such as many dunnarts and planigales. For some other species, the females breed only once per year for one or two years, and the males breed only once per lifetime, for example, antechinuses, phascogales and kalutas.

Species that breed only once per year are typically highly synchronized on the same date each year and give birth in spring. Young emerge from nests in summer, when there is peak abundance of prey but also a heightened risk of fire.

Previous research has examined fire impacts on several individual dasyurid species, but fire impacts are unknown for many others. Conservation managers need insight into which species are at greatest risk from fires and the factors that will exacerbate negative impacts.

Main aim of research

This study aimed to examine how fire influences populations of dasyurid species, and whether life history traits (such as breeding patterns) or habitat types make some species more resilient or sensitive to fire.

Population monitoring data, and information on fire impact, is not available for all 64 dasyurid species in Australia. Identifying patterns that reveal which species are more or less sensitive to fire would allow conservation managers to identify which species are likely to be at greatest risk from planned and unplanned burns.

What we did

We compiled the findings of all available published studies and theses which monitored the response of a dasyurid population to fire.

We were able to find 14 relevant studies on 13 of Australia's 64 dasyurid species. These studies monitored population sizes for two days to three years before fire, and three days to 15 years after fire.

We used a range of statistical analysis techniques to look

for patterns in the response of dasyurids to fire across all studies (a meta-analysis).

In particular we examined the effect of breeding strategies, to compare dasyurid species that breed once per year and once per lifetime, with species that breed multiple times a year and throughout their lives.

We also examined the response of species from different habitat types, for example, arid zone species compared to forest species.

BELOW: Bulburin fire. Image: Diana Fisher



Key findings

Our key finding was that all the dasyurid species we analysed were disadvantaged by fire, regardless of their life history, because their populations decreased in its aftermath.

Our comparison of species with different breeding strategies showed that species that breed once per year and once per lifetime experienced greater population declines after fire than did species that breed multiple times a year or multiple times in their lives. This indicates that species with a more flexible breeding strategy are more resilient to habitat disturbance caused by fire.

Most studies showed that populations of dasyurids had a delayed decline after fire. This strongly suggests that individuals died more often from secondary effects than from the fire itself. The secondary effects that cause the decline of dasyurid populations include the reduction of food sources such as leaf-litter insects and the removal of vegetation cover, which in turn makes these small mammals more vulnerable to predation, especially by introduced predators the red fox and feral cat.

Arid zone species that breed multiple times a year or multiple times in their lives, such as dunnarts and ningauis, showed smaller reductions in their populations after fire than species which inhabit forested areas and breed once per year or once per lifetime.

This offers support to our finding that dasyurid species that have more flexible breeding patterns are more tolerant of fire. A further possible explanation is that arid-adapted

species are less reliant on vegetation cover and more reliant on burrows. This means that when a fire removes arid zone vegetation cover it is not as dangerous for the survival of arid-dwelling dasyurids as it would be for forest-dwelling species, which are heavily dependent on vegetation cover. Another plausible reason is that species living in these harsh arid environments have simply adapted greater resilience to unfavourable weather conditions and disturbance events.

Studies that reported a relatively small negative response to fire by dasyurids involved fires that were either prescribed burns or wildfires of low intensity. Studies that showed dasyurids having a medium to large negative response to fire involved large-scale high-intensity wildfires, such as the Black Saturday fires in Victoria.

Wildfires are often uncontrolled and extensive. Conversely, prescribed burns are controlled, have boundaries, and seldom remove canopy and fallen timber. Thus prescribed burns are less likely to have severe negative effects on biodiversity.

Limitations

We were only able to identify 14 suitable studies, representing just 13 (~20%) of the total 64 dasyurid species currently found in Australia. Further, there are complexities in measuring the impact of wildfire with accuracy, because possible control sites tend to be burnt and due to the lack of data about pre-fire conditions. Some studies could not exclude external factors such as weather which may influence how abundant dasyurid populations are. Finally, while we were able to demonstrate that a species' life history influences its resilience to fire, other factors such as the mobility of species and flexibility of habitat use may also be important.

BELOW: Silver-headed antechinus.
Image: Harry Hines, QPWS



Implications

Fire poses a threat to dasyurids, and the extent of that threat is influenced by the species' breeding strategy and the intensity of the fire.

Land-owners, governments and agencies tasked with managing fire and designing fire management policies should take into account the needs of dasyurid species present at a site. Fire management where such species are present needs to be delicately planned and executed.

Species with restrictive and rigid breeding patterns, such as the dasyurid species that breed once per year or once per lifetime, usually have just the one chance to produce a generation that replaces the old one, and ensure the survival of their populations. A disturbance such as fire can jeopardise this chance and place the persistence of the population

at stake. Conservation managers of threatened dasyurids that fall in this group, such as the silver-headed antechinus and red-tailed phascogale, must carefully consider fire management at sites where populations are present.

The presence of unburnt refuge patches could enhance the survival and recovery of small mammals like dasyurids during and after fires. For this reason, prescribed burning should be patchy and exclude carefully selected areas of refuge to help reduce secondary effects that can limit the persistence of small mammals in the aftermath of fire.

Our study found that a patchy low-intensity burn will have far less negative impact on a population than a large high-intensity wildfire. As such, conducting low-intensity prescribed burns to reduce fuel loads and the risk of large wildfires

might be beneficial for the conservation of these species.

However, even prescribed burns will have an impact on species so the frequency and seasonal timing of prescribed burns should still be carefully considered. For example, frequent prescribed burns could lead to ongoing population decline by altering the habitat even if they prevent a high-intensity wildfire.

If prescribed burning is necessary in habitat that supports dasyurid species that breed once per year or once per lifetime, it should take place when the population has already successfully reproduced, replacing the previous generation, and has stabilised. It should not take place during times where the population is particularly vulnerable, such as early summer.

Cited material

Lee, A.L. (2020). Fire response in Dasyurids. Honours thesis, The University of Queensland.

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Bulburin burnt landscape. Image: Harry Hines, QPWS