Science for Saving Species

Research findings factsheet

Project 4.1.7

Threatened Species Recovery Hub

National Environmental Science Programme

Digging by quenda reduces fuel loads in an urban reserve

In brief

Reintroductions of native animals usually take place in remote landscapes for conservation aims; however, in this study, we work with quenda that were translocated into remnant vegetation in Craigie Bushland, an urban reserve located approximately 20 km north of Perth, Western Australia. We wanted to understand how reintroducing this digging mammal to banksia woodland habitat in the reserve could alter it.

Litter is a major component of the surface fuel layer. By disrupting the amount of litter on the ground, digging mammals act as ecosystem engineers, altering the amount of surface fuel, potentially influencing fire behaviour.

In many landscapes, including peri-urban areas, fire management to reduce fuel loads is complex and challenging. The reintroduction of previously common digging mammals, many of which are now threatened, to urban and peri-urban reserves may have the added benefit of reducing fuel loads where fire poses a risk to human settlements. This is especially relevant to the south-west of Australia, the native range of quenda, which features a Mediterranean climate that is becoming more fire-prone under climate change.

We found that digging by quenda clearly has the capacity to reduce fuel loads and the spread of fire, and recommend further study to assess the feasibility of reintroductions of digging mammals to other locations.

Digging mammals like quenda are ecosystem engineers. Image: Leonie Valentine

Background

Mammals that dig for food, or create burrows, are often considered ecosystem engineers. By displacing soil, these digging mammals may enhance many ecosystem functions, including water infiltration, nutrients and microbes found in soil, and seedling recruitment, all of which can influence vegetation and the structure of landscapes. Extensive disturbance to soil can potentially change the surface microhabitat, such as the amount and depth of litter and the amount of bare ground.

Australia has many digging mammals, such as the quenda (*Isoodon fusciventer*), a medium-sized (800–1200 g) marsupial bandicoot. Quenda are prolific diggers, foraging underground for food that includes tubers, invertebrates and fungi by digging and displacing soil. A single quenda will displace around four tonnes of soil per year, potentially changing the surface microhabitat.

Litter is a major component of the surface fuel layer, which is important to how fire behaves. This means that by disrupting the amount of litter on the surface, mixing soil and covering litter with soil, digging mammals may also reduce the amount of fuel, potentially influencing fire behaviour.

The University of Western Australia · City of Joondalup · Department of Biodiversity, Conservation and Attractions

Background (continued)

Although previously common throughout south-western Australia, quenda have declined throughout much of their range due to habitat loss and predation by introduced pest animals the red fox and feral cat. However, quenda have been reintroduced to an urban bushland reserve, Craigie Bushland, in Perth. The reserve is on Whadjuk Noongar land and is managed by the City of Joondalup, which constructed an approximately 42-hectare predator-proof fence in 2010 to exclude cats and foxes.

The Western Australia Department of Biodiversity, Conservation and Attractions undertook a reintroduction translocation of 46 quenda in mid-2013. Quenda have flourished in the reserve and, at the time of this study (April – June 2017), it was predicted that the reserve held approximately 100 to 120 of these marsupials.

The vegetation in Craigie Bushland consists of banksia woodlands, including the threatened ecological community *Banksia Woodlands on the Swan Coastal Plain*, which is listed as Endangered under the EPBC Act due to ongoing threats including habitat clearing, invasive species and changes to fire regimes. Banksia woodlands are also considered to be among the most flammable woodlands in Australia and, while they require fire, they often present complex challenges to fire management, especially in reserves located close to human settlement.

Reducing fuel loads in forest ecosystems, particularly in Mediterranean climates such as those of the south-west of Australia, is becoming increasingly important due to climate change bringing a higher incidence of fire weather. The cessation of traditional burning practices by Indigenous people and altered fire management coupled with the loss or decline of many digging mammals means that fuel loads are likely to be higher and more uniform across landscapes now than they were historically.

What we did

Quenda were reintroduced into remnant vegetation in Craigie Bushland, an urban reserve located approximately 20 km north of Perth, Western Australia.

We compared differences in soil disturbance produced by quenda, estimated surface litter and predicted the rate of spread of fire between open (quenda-accessible) and fenced (quenda-excluded) plots. The results shown here were surveyed during April – June 2017, four years after quenda had been translocated into the reserve.

To examine the effect of quenda digging on microhabitat, we used five paired plots, open and fenced, that had been erected in 2014, nine months after the quenda had been reintroduced. The fenced plots only showed diggings made by quenda before the fencing was erected.

In each plot, we estimated the amount of soil disturbed by quenda by counting all foraging pits, and measuring the soil exposed by each pit. (At Craigie Bushland, quenda were the only digging mammal present, and their foraging pits were easy to identify.)

We then measured the microhabitat characteristics (the percentages of litter cover, vegetation and bare ground and the depth of surface litter) every two metres along the edge and in the interior of each plot.

To estimate surface fuel loads in each plot, we used a formula based on the average litter depth and litter mass. This gave us a value for surface fuel, which we then converted to tonnes per hectare.

We also used the estimated fuel mass for each plot to evaluate the predicted rate it would give for forward spread of a fire under high and low fire danger conditions, according to the McArthur Mk5 Forest Fire Behaviour model.

LEFT: Quadrat, 50x50cm, fenced; RIGHT: Quadrat, 50x50cm, unfenced. Image: Leonie Valentine

Research aims

Our aim was to monitor the effect of digging activity by quenda following their reintroduction to bushland in a fire-prone Mediterranean climate. Specifically, we wanted to know whether this digging could alter microhabitat characteristics that subsequently influence surface fuel loads, thereby potentially altering fire behaviour.

Quenda diggings in bushland. Image: Leonie Valentine

Key findings

Our key finding is that the foraging activities of quenda in the urban bushland reserve increased bare ground cover and reduced litter cover and depth, thereby reducing surface fuel loads and the predicted rate of spread of fire.

Litter: Litter depth, litter cover and estimated litter mass were all found to be significantly higher in the fenced plots which excluded quenda.

Bare ground: Area of bare ground was higher in the open plots as a consequence of quenda digging.

Fuel load: The estimated surface fuel loads in the open plots where quenda foraged were nearly half that of fenced plots (3.6 versus 6.4 tonnes per hectare, or ~56%).

Fire spread: Under a scenario of high fire danger, the predicted rate of spread of fire in areas with quenda foraging was ~45% lower than the predicted rate of spread of fire in areas where quenda were excluded.

The foraging behaviour of quenda, digging for underground food, created a visibly patchy distribution of surface litter.

There was a substantial difference in the number of quenda digs observed between the two treatments, with approximately 17 times the number of digs in the open plots, which quenda had access to, compared to the fenced plots, which they were excluded from.

Fire behaviour modelling using the estimated surface fuel loads showed a significantly lower predicted rate of spread of fire in open plots where quenda foraged than in fenced plots that excluded quenda. This held under fire conditions where the estimated rate of spread of the fire was both low (29.2 metres per hour in open plots compared to 51.4 metres per hour in fenced plots) and high (74.3 metres per hour compared to 130.4 metres per hour). The fire behaviour models indicated that the estimated rate of spread was close to 1.8 times faster in plots where quenda were excluded than in plots where they foraged; meaning that a fire in the area without quenda would travel quicker than a fire in the area with quenda.

Our findings clearly indicate that the digging activities of quenda in urban bushlands have the capacity to alter fuel loads and potentially the spread of fire.

While reintroduction programs face many challenges, they are an increasingly common management practice, not just for the conservation of species but also for the ecosystem services a species provides.

Few reintroduction programs have taken place in urban areas, but awareness is growing of the benefits of engaging people with nature.

In Australia, the threat of predation from introduced cats and foxes restricts the broad-scale reintroduction of critical weight-range mammals outside fenced reserves or islands; however, the reintroduction of such mammals may still be feasible in some urban areas. Reintroductions into small urban reserves will nevertheless come with many management challenges, including proximity to urban infrastructure and isolation from other habitat patches. But, encouragingly, quenda (and some other digging mammal species) still occur outside of fenced areas.

BELOW: Unfenced habitat in Craigie Bushland reserve. Image: Leonie Valentine

Implications and recommendations

These findings will be of most importance to urban land managers, environmental NGOs, conservation translocation managers, government agencies and fire departments, who may consider reintroductions of digging mammals to help reduce fuel loads.

The role of digging animals in altering fuel loads and influencing fire dynamics has so far been largely overlooked, while the loss or decline of many such species may have altered fire regimes in landscapes. Our results indicate that within a short time frame (less than four years since reintroduction, and three years since fence construction) the successful translocation of a single digging mammal species can alter fuel load characteristics in an urban area.

From a fuel management perspective, it will be important to understand how many digging animals would be required to create fuel load reductions that significantly alter fire behaviour. This will presumably vary depending on the species and the habitat and is a potential topic for further research.

In urban bushland reserves, where reducing fuel loads is a challenge for land managers, reintroducing previously common digging animals may potentially have value as a complementary fire management tool, even if it comes with its own set of challenges.

Our study provides extra reason to conserve and protect quenda and other threatened native digging mammals. Knowledge about pre-European densities of Australian mammals is lacking, but historical accounts indicate that many species, including the quenda, used to be abundant. Prior research has documented present-day quenda densities of around two quenda per hectare in both fenced and unfenced areas that are similar to what we observed at Craigie Bushland. This suggests that although quenda are currently absent from many bushlands, such habitat may yet be able to support populations large enough to significantly reduce fuel loads in urban areas once a population has established. We recommend further research to gauge how feasible reintroductions of digging mammals may be in other places.

Many Australian mammals, including bandicoots like quenda, need unburned habitat that can act as refuges from invasive predators. We saw that digging by quenda at Craigie Bushland left a patchy distribution of litter cover between dense understorey vegetation patches where quenda shelter. As patchiness of surface fuels changes the way in which fire progresses and the spread of fire can be slowed by bare areas, the patchiness in litter created by quenda digging may play a protective role for denser vegetation. This could help quenda populations persist, especially in isolated urban reserves where quenda are sensitive to large-scale fires.

Most urban bushlands contain non-native plant species, and it is not clear how digging by native mammals will interact with such plants. As non-native plants can influence fuel loads and fire behaviour, we also recommend further research that examines the impact of digging animals on non-native plants, especially invasive species.

Further Information

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Cited material

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