Science for Policy

Research findings in brief

Project 1.1.1

Threatened Species Recovery Hub

National Environmental Science Programme

The impacts of fire regimes on key resources for the threatened Gouldian finch

In brief

The Endangered Gouldian finch (*Erythrura gouldiae*) is found only in the tropical savannas of northern Australia. It feeds exclusively on grass seed. An increase in the frequency, extent and intensity of fires in the region is diminishing the availability of the grass seed that the species depends on.

In this study, we examined the effects of fire regimes (season, frequency, time since fire) on plant density, seed production, seed nutrition and overall seed abundance on the bird's most important breeding season food source, the annual grass *Sorghum stipoideum*. We monitored this grass species over Gouldian finch breeding habitat near Wyndham, Western Australia, over three consecutive years while also considering local fire history over 16 years.

We found that fire extent and seasonality had the greatest impact on overall seed abundance. Gouldian finches benefited most from low-intensity patchy fires in the early dry season. This regime increased the availability of newly burnt areas as well as increasing the nutritional quality of sorghum seed (particularly crude fats), which in turn increased the breeding success of the birds. It also ensured availability of perennial grass seeds (e.g., *Triodia* spp.) in unburnt areas for the non-breeding season.

Too little fire leaves litter, reducing sorghum plant and seed density in the following year, but too extensive fire reduces perennial grasses for the non-breeding season.

Very hot fires, as occur in the late dry season, kill sorghum seeds on or near the soil surface, and reduce sorghum plant and seed density in the following late dry and wet seasons. A history of high frequency, late dry season fires at sites also reduced the availability of tree hollows, which are required for breeding.

Gouldian finch. Photo: David Bettini

Sorghum stipoideum *with mature seeds. Photo: Ian Radford.*

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Gouldian finch. Photo: David Bettini

Background

The Gouldian finch is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act (1999)*. This once-common grass finch is now found only in scattered locations across northern Australia. Even though finch trapping stopped in the 1980s, populations have not regained their former size or range. Unlike other finches, this grass finch does not supplement its own or its hatchlings' diet with other sources of protein.

Previous studies have inferred that shortages of grass seed and loss of their diversity under current fire regimes have led to critical limitations that are having an impact on the abundance of the Gouldian finch. These studies have investigated annual sorghum species grass seed populations and their responses to northern Australian savanna fire regimes; however, little is known about the effects of fire regimes on the annual availability of seed for breeding Gouldian finches.

Sorghum seed, especially *Sorghum stipoideum*, is an annual native spear grass found only in tropical northern Australia. Sorghum seed is the main source of food for Gouldian finches throughout the dry season (late March to October), which is when the birds breed. Therefore, annual sorghum seed availability is important in the selection of habitat by Gouldian finches. *Sorghum stipoideum* forms stands in a mosaic of low and high density patches across the landscape, with growth and reproduction complete by the end of the wet season (end of March), when seed fall occurs.

With a reduction in small-scale traditional burning practices, northern Australia's tropical savannas have experienced a shift in fire regimes, characterised by more frequent, more extensive and hotter fires occurring later in the dry season.

What we did

This study investigated the availability of key breeding resources required by the Gouldian finch over three years to pinpoint where the key limiting factors to finch population recovery might be. We focused primarily on the availability of sorghum seed, especially *Sorghum stipoideum*, and tree hollows under different fire regime scenarios.

Study sites were located in known breeding habitat within a 30 km radius of the town of Wyndham, in the east Kimberley region of Western Australia.

We undertook five sub-studies to investigate how fire regimes influence the following factors, which are possibly limiting the success of Gouldian finches. Fire regime is primarily based on season, frequency and time since fire, but we also considered patch size, total area burnt, percentage burnt and cluster factors.

1. Choice of breeding sites
2. Availability of soil nutrients and the nutritional quality of sorghum seed
3. Timing of seed production (window of availability)
4. Production of sorghum seed
5. Availability of tree hollows

Evidence underpinning our analyses included:

- Monitoring *Sorghum stipoideum* at 42 plots across five Gouldian finch breeding sites over three consecutive years (2013–2015)
- Monitoring data of breeding success in artificial nest boxes over a period of eight years (2008–2015)
- Fire history based on North Australian Fire Information (NAFI) burned area mapping (processed from Landsat satellite imagery), including at least one satellite image per month from 2006 to 2014.
- Experimental burns conducted at the abandoned Wyndham Golf Course in 2014 to compare the effect of fire season on density and productivity of *Sorghum stipoideum*. The four treatments included low-intensity very early dry, moderate-intensity early/mid dry, moderate-intensity early wet season burns and a control.

Key findings

Our key finding is that Gouldian finches benefited most from low-intensity patchy fires within their breeding sites. This regime increased the availability of newly burnt areas as well as increasing the nutritional quality of sorghum seed (particularly crude fats), which in turn increased the breeding success of the birds. At the same time, this regime retained a range of longer unburnt areas with decreased fire frequency (which also reduces the quality of sorghum seed). Seeds higher in fat may benefit fledglings and may also increase the survival of adults and juveniles through periods of food shortage.

Plant growth can be stimulated by recent fire, as soil nutrients are often enriched due to nitrogen mineralisation and fixation with some fires, and we were able to demonstrate increases in inorganic nitrogen at our study sites following fire. Fire can also enhance the emergence and survival of sorghum species seedlings, by removing leaf litter, reducing seed barriers and reducing competition for light and resources. Previous studies have found that *Sorghum stipoideum* decreased initially following fire but that populations recovered after a year, and that long-unburnt sorghum can also decline substantially. We did not find effects of time since fire on sorghum populations and seed density in this study, which is probably because of the low-productivity, rocky habitat that Gouldian finches breed in. Under the current, relatively frequent fire regime in Gouldian finch breeding habitat, it is unlikely that changes in time since last fire are having a significant impact.

Gouldian finches did best in years with multiple small fires, and worst in years with a few large fires, due to the greater availability of perennial grass seeds in unburnt areas. Perennial grass seeds are a crucial resource during food shortage periods when sorghum has run out by the end of the dry season, throughout the wet season and in the lead-up to breeding when sorghum seeds become available again in March and April.

Fire season was the most important attribute of fire regime for sorghum seed that we were able to identify. While sorghum seed is available from March or April through to October, it is usually insufficient for breeding after July. By November and December both adult and fledged juvenile finches alike are subject to periods of critical grass seed shortage due to seed burial in soil, germination after early rains, and because perennial grass seeds are not yet available. We don't yet know much about the timing of perennial grass seed availability during the wet season. However, we believe that under high-intensity fire regimes, there are long periods in the wet season when perennial grass seed is not available and plant density declines tenfold that Gouldian finches may be close to starvation. Extensive wet season burning also has the potential to completely remove sorghum species from sites.

In order to increase the amount of sorghum seed available to finches, it is best to burn at low to moderate intensity in the early dry season. Too little fire leaves litter, reducing plant and seed density in the following year. In addition, very hot fires kill sorghum seeds on or near the soil surface, and therefore also serve to reduce sorghum plant and seed density in the following season.

The availability of tree hollows was lowest at subsites that had a higher frequency of late dry season fires. These should be discouraged throughout finch breeding sites.

Sorghum seeds accidentally collected by Dr Anna Weier while driving off-road. Photo: Ian Radford

BELOW: Typical Gouldian finch breeding habitat with Sorghum stipoideum *understorey and* Corymbia dichromophloa *trees providing nest hollows. Photo: Ian Radford*

Recommendations

Ideal fire management would achieve a network of small burnt and unburnt patches at breeding sites and in surrounding areas, possibly involving hand burning multiple times during the late wet and early dry seasons.

Small patchy early dry season burns would increase soil nutrient flushes and the abundance and nutritional quality of sorghum seeds, but would also allow for development of mature, seeding perennial grasses to provide wet season seed resources for finches.

Future work to fully unravel the key ecological limitations for this tiny threatened grass finch might as a priority include investigation into their spatial movements, and their use of landscape resources (including the availability of perennial grass seeds) during the assumed periods of food shortage in the late dry and wet seasons.

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Further reading

Weier, A., Radford, I.J., Woolley, L.-A., Lawes M.J. (2018). Fire regime effects on annual grass seeds as food for threatened grass-finch, *Fire Ecology*, Vol. 14, Iss. 8. https://doi.org/10.1186/s42408-018-0019-3

Balanggarra rangers and Department of Biodiversity Conservation and Attractions staff conducting patchy prescribed burning to maintain grass diversity. Photo: Ian Radford

Further Information

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