

How habitat influences forty-spotted pardalote and striated pardalote occurrence on North Bruny Island

In brief

We compared the occurrence and density of an Endangered habitat specialist, the forty-spotted pardalote (*Pardalotus quadragintus*) with those of a common habitat generalist, the striated pardalote (*Pardalotus striatus*). This kind of comparison is valuable in systems where a generalist and a specialist coexist and share resources, since habitat disturbance can lead to higher competition, and specialists are known to be more vulnerable to changes in their environment.

We found that forty-spotted pardalotes only occurred in forests with white gums, and have a mean density of 2.7 birds per hectare in these areas. The density of forty-spotted pardalotes decreased in areas with abundant small trees (diameter at breast height of 1–15 cm) and trees with dead crowns

and increased in areas where larger white gums were abundant. The striated pardalote was widespread, but where white gums were present, they occurred at 2.1 birds per hectare, compared to 0.6 birds per hectare in forests where white gums were absent.

Within white gum habitat, the relative abundance of forty-spotted pardalotes and dead trees had a positive effect on the density of striated pardalotes, while small tree abundance had a negative effect. Our study reveals that, although widespread, the generalist pardalote is most abundant in the limited areas of habitat suitable for the specialist, and this indicates the need of future research to look at whether this pattern of occurrence exacerbates competition between them in resource-depleted habitats.

Background

Comparing patterns of occupancy and density of specialists and generalists species may offer useful insights into these patterns and how to identify important habitat features that may limit their populations at particular sites. We compared the occurrence and abundance of an Endangered habitat specialist, the forty-spotted pardalote (*Pardalotus quadragintus*) with those of a common generalist, the striated pardalote (*Pardalotus striatus*).

This kind of comparison is especially important in systems where a generalist and a specialist coexist and share resources, since habitat disturbance can lead to higher competition, and specialists are known to be more vulnerable to changes in their environment. In this context, we used a suite of approaches to quantify and compare population parameters of these two passerines which occur in overlapping geographical areas.

Forty-spotted pardalotes are a sedentary bird found only in Tasmania. They have become extinct across most of their former Tasmanian range due to deforestation and habitat degradation, and are listed by the IUCN as Endangered. By comparison, the striated pardalote is widespread throughout Tasmania and mainland Australia.



Forty-spotted pardalote. Image: Fernanda Alves



Background (continued)

Although part of the striated pardalote population is resident year-round, some migrate to mainland Australia to winter.

Both of these pardalotes are small, hollow-nesting birds with similar diets. Forty-spotted pardalotes forage almost exclusively on white gums (*Eucalyptus viminalis*) for arthropods (such as insects and spiders), lerps (crystallized honeydew produced by psyllid insects) and manna (sugary exudates produced by the white gum). Striated pardalotes exploit similar foods from several tree species.

Forty-spotted pardalotes are the only bird reported to be able to stimulate manna production from white gums with their elongated bill tips. The two species compete for tree hollows for nests and for foraging resources. The occurrence of forty-spotted pardalotes depends on the presence of white gums, and striated pardalotes also prefer areas with this tree species. Both pardalotes select areas with more hollows and mature trees, attributed to their breeding requirements; however, their patterns of occupancy and abundance in relation to forest type have never been quantified. Thus, these ecologically similar species offer an excellent opportunity to explore habitat requirement differences between a specialist and a generalist.

We predicted that forty-spotted pardalotes would be restricted to forests where white gums are present and that the occupancy and abundance of striated pardalotes would be higher within white gum habitat. We did not expect the abundance of striated pardalotes to affect forty-spotted pardalotes, as specialists are known to thrive in their optimal habitat.

Main aims of the research

We compared occurrence and abundance of an Endangered habitat specialist, the forty-spotted pardalote, with those of a common generalist, the striated pardalote. We used a range of approaches to quantify and compare the populations.

We aimed to identify habitat preferences of the forty-spotted pardalote, by:

- i. evaluating patterns of occupancy in areas where white gums are present/absent;
- ii. estimating average population density and size; and
- iii. identifying fine-scale habitat characteristics that might affect pardalote density within white gum forest.

What we did

In white gum forest, we looked for fine-scale habitat variables related to forest maturity that could affect density of both species. This included the availability of tree hollows and foraging habitat. We tested whether the relative abundance of the forty-spotted pardalote affected the abundance of the striated pardalote and vice versa.

The study was conducted on North Bruny Island, representing approximately a quarter of the current global distribution of the forty-spotted pardalote (see Figure 1). We established 100 random survey sites (53 in white gum forest, 47 in other *Eucalyptus* forest), spaced more than 200 m apart and more than 50 m from habitat boundaries.

We conducted fieldwork immediately after the breeding season. The same observer visited all sites three times, between January and May 2016, to conduct a 10-minute point count. Birds were detected using calls and visual observation. All sites were surveyed for the first time between January and February; for the second time between March and April; and for the third time in May.

We quantified the forest characteristics at each site, recording a number of features, including the number of tree species, trunk diameter at breast height and number of hollows visible from the ground.

We used occupancy models and distance sampling to evaluate presence/absence and population density of pardalotes relative to habitat features and to estimate the size of their populations in the study area. We developed the occupancy models to solve the problems created by imperfect detectability of the birds. These models use information from repeated observations at each site to estimate detectability.

We fitted single-season occupancy models to estimate site occupancy and detection probability. We tested the effect of survey visit and time after sunrise on detection. We looked at the effect of habitat type on the occupancy for both species. We also fitted hierarchical distance sampling models to examine local variation in density driven by habitat variation.

Key findings

Forty-spotted pardalotes only occurred in forests where white gums were present. Our statistical model estimated a forty-spotted pardalote density of 2.7 birds per hectare in white gum forest, and a population of 2229 across the white gum forests of North Bruny Island. Our population estimate for the forty-spotted pardalote on North Bruny Island were substantially higher than previous estimates for the entire island of 450 individuals in 2010, but our estimates cannot be compared to previous estimates due to differences in the survey methods. Also, our study was conducted immediately after the breeding season so it is likely to have included independent juveniles.

Striated pardalotes occurred throughout the whole study area, but their abundance was highest in white gum forest, estimated at 2.1 birds per hectare compared to an estimate of 0.6 birds per hectare in other Eucalypt forest types.

Not all white gum forest in the study area was equally suitable for forty-spotted pardalotes, with variation in forest characteristics affecting abundance, such as the availability of tree hollows. For example, forty-spotted pardalote density increased with increasing abundance of large white gums, up to 4.2 birds per hectare.

Smaller trees had a negative effect on forty spotted pardalote abundance, which is likely to be related to the availability of nest sites as hollows suitable for wildlife in these forests are more likely to occur in larger trees. We found that forest characteristics had effects on the abundance of both species. The density of forty-spotted pardalotes decreased in areas



with abundant small trees and trees with dead crowns, but increased in areas where larger white gums were abundant.

A positive relationship was found between the relative abundance of forty-spotted pardalotes and the density of striated pardalotes. Forty-spotted pardalotes can stimulate manna production and striated pardalotes feed on manna opportunistically. Therefore, it is possible that striated pardalotes take advantage of the

food-rich territories of forty-spotted pardalotes, but this needs further investigation.

We did not find an effect of the relative abundance of striated pardalotes on the density of forty-spotted pardalotes. This could be due to a limitation of our study, with some of the data collected when part of the striated pardalote population had already migrated north. Further research on competitive exclusion between these two species is required.

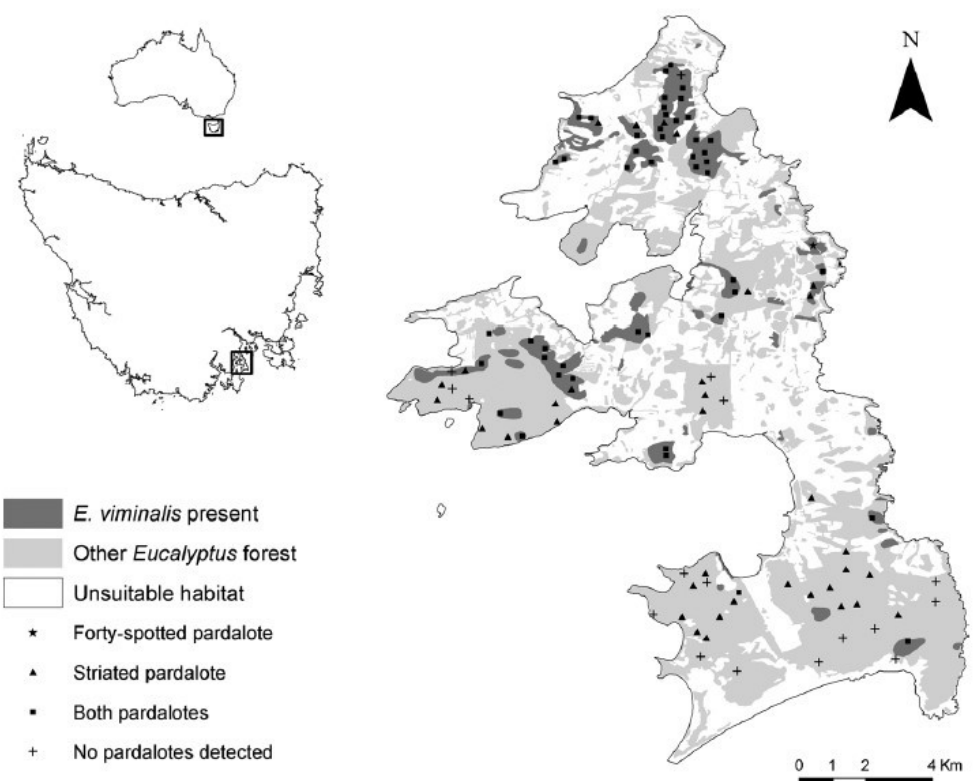


Figure 1. Map of the study areas on North Bruny Island, Tasmania. Symbols show the species detected at each point.

Cited material

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Implications and recommendations

From a conservation perspective, the variation in abundance of the habitat specialist with forest characteristics agrees with evidence from other species that forests with large, hollow-bearing trees are important for conservation. Within the forty spotted pardalotes' preferred habitat where the food plant grows, mature white gum forest supports more forty-spotted pardalotes than recently disturbed forest.

Accounting for variation in critical habitat features (e.g., tree hollows,

tree trunk diameter) may improve the accuracy of population estimates for both species, with important implications for detecting changes in their abundance.

These results are a step towards understanding the patterns of distribution and abundance of forty-spotted pardalotes, and improving conservation planning for this Endangered species.

In their optimal habitat, specialists are usually the dominant species, but in degraded habitats they can become the subordinate one.

Whether striated pardalotes exclude forty-spotted pardalotes where nesting hollows in trees are limited, such as in disturbed forest, should be investigated in the future.

Other recommendations for future work are whether forty-spotted pardalotes miss breeding opportunities in disturbed areas as a result of competition; and whether increased competition with striated pardalotes affects the adult body condition of forty-spotted pardalotes, or can result in their exclusion.



Bruny Island, Tasmania. Image: Lachlan Francis

Further Information

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