Science for Saving Species

Research findings factsheet

Project 2.3.3

Threatened Species Recovery Hub

National Environmental Science Programme

Will feral cat control on Christmas Island lead to an increase in rat impacts on threatened birds?

In brief

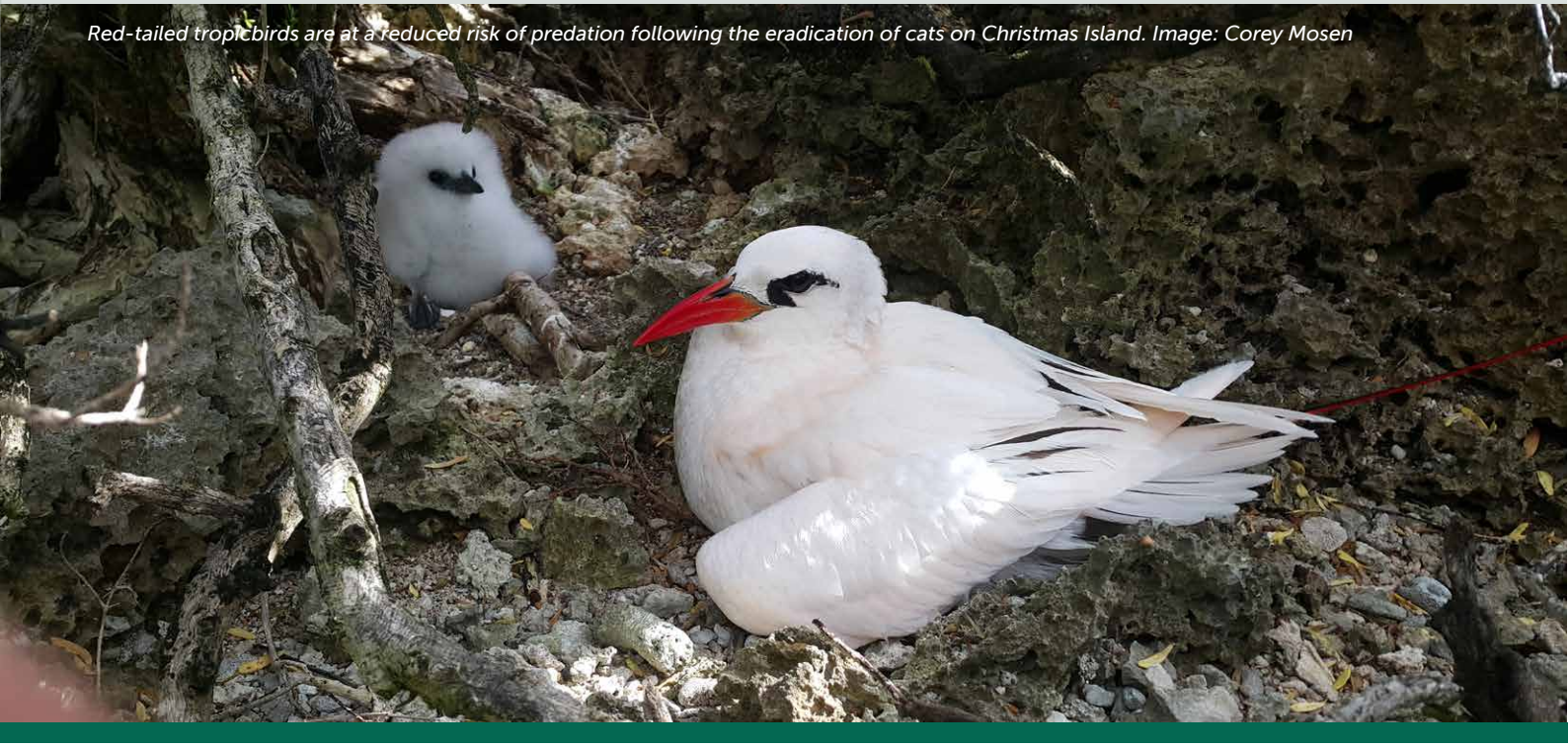
Christmas Island is home to threatened bird species including the red-tailed tropicbird and the Christmas Island thrush, both of which are preyed upon by feral cats and rats. We investigated whether an existing eradication program for feral cats would cause black rat populations to increase, reducing the conservation benefit of the cat eradication.

Using a variety of surveys and modelling methods, we assessed the current population size and spatial variation of rats on Christmas Island, and estimated their rates of predation on bird nests. From these models, we investigated the potential for rat populations, and their impacts to native birdlife, to increase following the removal of cats.

We found that there were rats across the whole island but at lower densities than on many other tropical islands. Rat abundance was greatest in drier and disturbed sites. Rats became less common as red crabs were increasingly abundant. Thus, red crabs may be both competing with and preying on the rats.

We determined the rate at which rats currently impact two focal bird species, and the rat population threshold at which rats could impact bird populations. This threshold was used to inform recommended monitoring protocols and triggers for intervention actions.

Overall, our findings indicate that removing cats will not lead to a large increase in rat impacts on Christmas Island. This research is useful for Christmas Island conservation managers, as we have provided evidence in support of the feral cat eradication program.



Red-tailed tropicbirds are at a reduced risk of predation following the eradication of cats on Christmas Island. Image: Corey Mosen

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Australian Government Department of Infrastructure, Transport, Regional Development and Communications

Australian Government Parks Australia

Background

Invasive species are among the greatest threats to biodiversity in the world and are especially devastating on islands. Eradicating invasive species from islands has led to clear conservation gains for endemic and threatened species worldwide.

In ecosystems where multiple invasive species are present, management quickly becomes complex, as there are many elements interacting in various and often unknown ways. Eradicating all invasive species at the same time is considered the best way to maximise benefits, whilst also minimising the risk of the negative effects that could happen when a single invasive species is removed in isolation. Doing everything at once is costly, however, and not always feasible or necessary. Deciding between doing everything, doing nothing, or removing a single invasive species and hoping for the best is difficult. Investigating responses to single invasive species removals as they progress and evaluating ecosystem outcomes to ensure that actions had the intended affect is an alternative that we take.

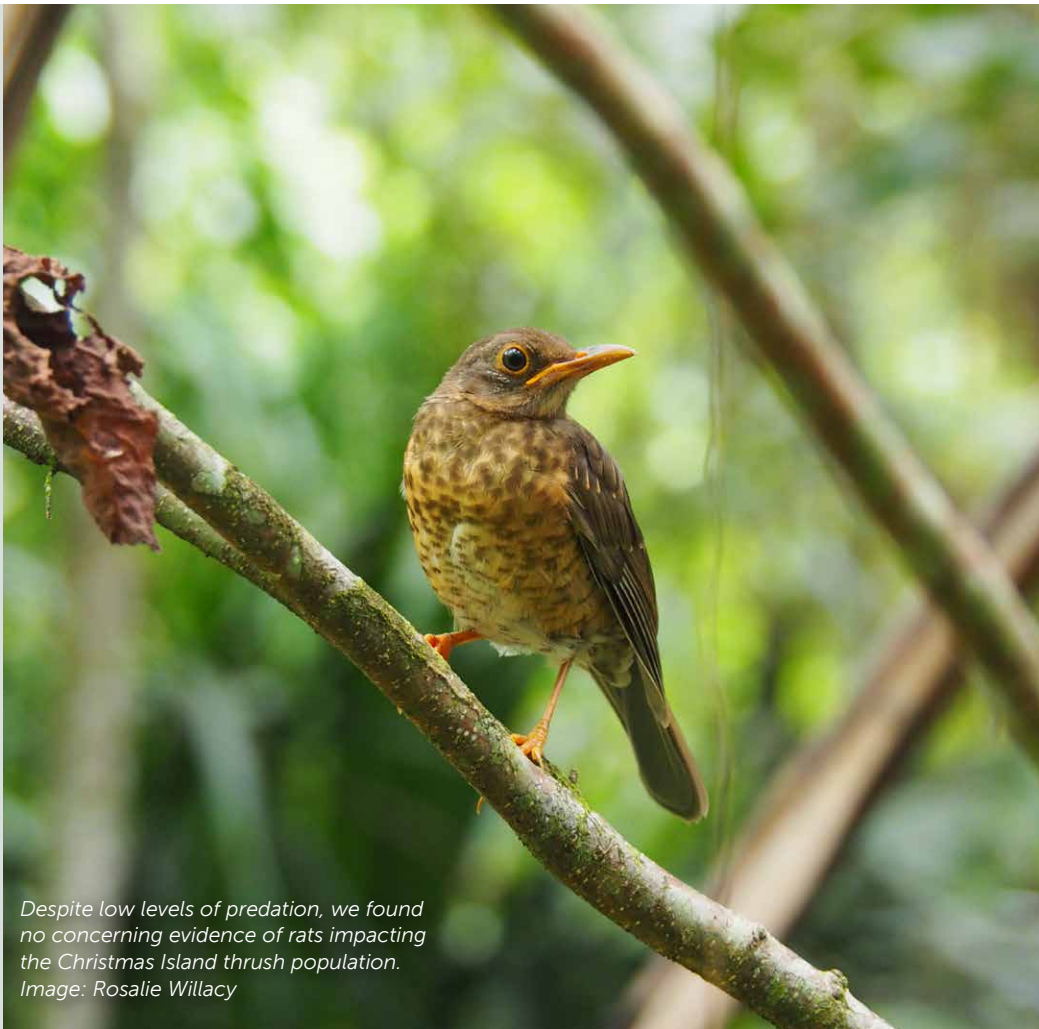
Christmas Island is a unique ecosystem with high levels of endemism and high rates of extinction. The island ecosystem is characterised and structured by the hyper-abundant red crab (*Geocarcoidea natalis*). Feral cats (*Felis catus*) and black rats (*Rattus rattus*) have contributed along with several other invasive species (yellow crazy ants, wolf snake, giant centipede) to the extinction of at least seven species and declines in many other native species.

A feral cat eradication program is underway on Christmas Island, carried out by Parks Australia. The introduced black rat, another species that cats prey on, is not being eradicated. Both feral cats and rats impact native threatened birds, including the Christmas Island thrush (*Turdus poliocephalus erythropleurus*) and the red-tailed tropicbird (*Phaethon rubricauda*). If cat removal allows the rat population to increase substantially, then native birds may not benefit or, if the rat predation exceeds previous rates of cat predation, the birds may be even worse off.

Research aims

We aimed to determine whether cat eradication alone on Christmas Island would improve conservation outcomes for native birds, or if ongoing control of rats is also required. To answer this question, we needed to:

- describe the current population size and spatial variation of rats on Christmas Island, and their rates of predation on bird nests;
- investigate the potential for rat populations and associated impacts to increase following the removal of cats; and
- determine the point at which rat impacts could limit bird populations. This could be used to inform a monitoring protocol with triggers to guide managers about when to respond with additional rat control methods, if needed.



Despite low levels of predation, we found no concerning evidence of rats impacting the Christmas Island thrush population. Image: Rosalie Willacy

What we did

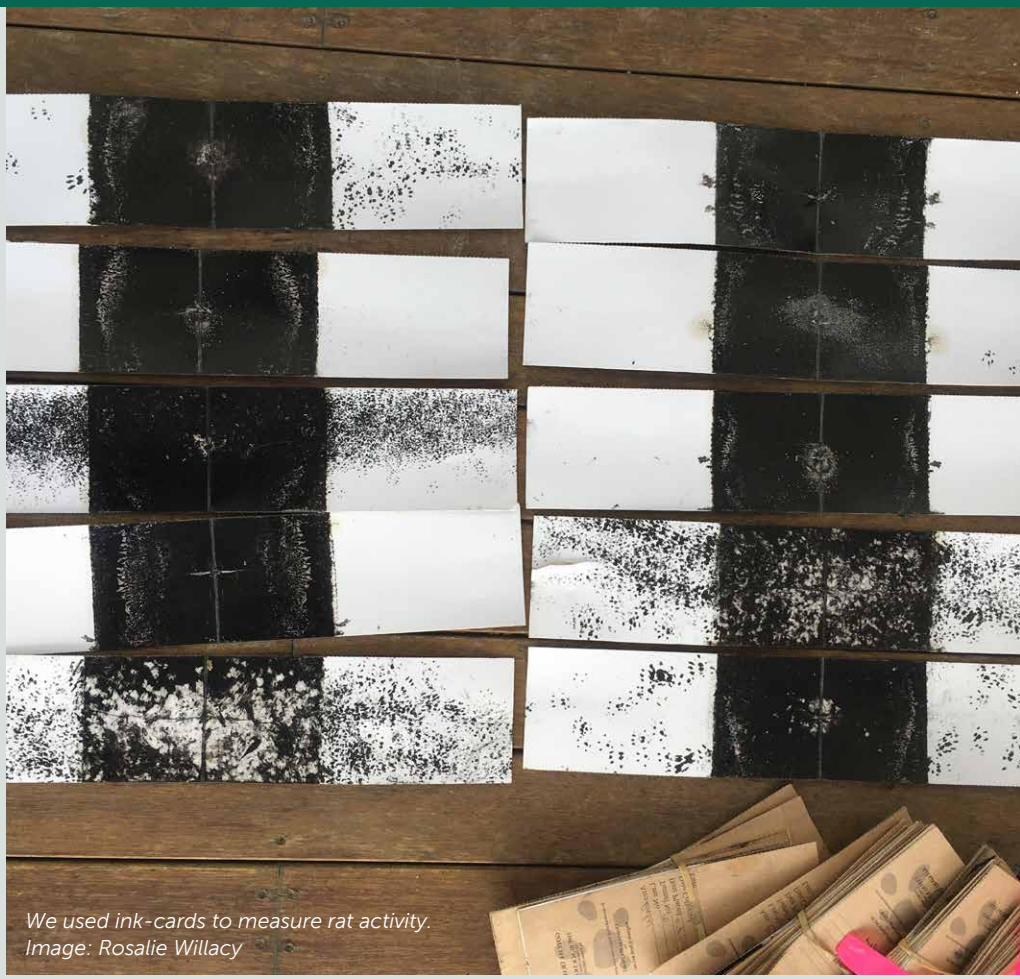
Researchers from The University of Queensland conducted fieldwork on Christmas Island between 2017 and 2019 in collaboration with Parks Australia, working with staff from Christmas Island National Park and volunteers.

First, we described the population size, and spatial patterns of the rat population's density and activity, which required trialling a number of survey methods to outwit the island's diverse and numerous land crab community.

We used an ink-card monitoring technique to measure rat activity. The method utilizes a tunnel with a lure and ink pad in the middle; after standing on the ink pad, as animals leave the tunnel, they leave footprints on blank card. Species can be identified by their footprints.

We employed cage traps for capture-mark-recapture density estimations, and hair traps for genetic approaches to capture-mark-recapture density estimation. We then explored relationships between rat activity and density, and a number of environmental variables.

We developed spatial models for rat abundance, and using these, estimated the total rat population size on Christmas Island. We estimated the predation toll of cats on rats using cat gut content analysis and cat density data provided by Parks Australia. From these data, we investigated how likely it was that cats suppressed the Christmas Island rat population, given our estimates for the rat population and published information on rat demographics. This allowed us to gauge whether rat population increases would be likely if cats were eradicated.



We used ink-cards to measure rat activity. Image: Rosalie Willacy

To determine if or when a rat population increase would matter, we investigated the relationship of rat abundance to bird abundance, and also measured the current rates of rat impact on nest success using motion sensor cameras. We had two focal bird species for the study of rat impacts on nests: the Christmas Island thrush and Indian Ocean red-tailed tropicbird. For the red-tailed tropicbird, we were able to compare our rat activity and impact results to those from a previous study in 2009. The 2009 study took place before cat removal efforts, allowing us to determine whether rates of both cat and rat predation had changed with cat control. We also used population viability modelling to determine what level of rat impact would start to affect the population of red-tailed tropicbirds.

Finally, we used structured decision-making tools to compare and evaluate the suitability of alternative monitoring strategies. These strategies aimed to detect changes in rat abundances and impacts that exceeded the scale of seasonal change observed during our study, or abundance and critical impact thresholds suggested by population viability modelling. To inform the choice of a monitoring program that will take place alongside ongoing cat management, we also evaluated the suitability of monitoring approaches to detect change based on criteria including detection probability and interference, power analyses and cost.

Key findings

Rats were found across all habitats of Christmas Island but at lower densities (average of 31 rats per hectare) than observed on tropical islands elsewhere (i.e., 1.2–119 rats per hectare). Rat activity was positively related to density and varied over the survey period. The variation was probably in response to seasonal resource availability as well as to rainfall-related responses in red crab activity.

Rats were most abundant in drier habitat, including disturbed vegetation such as historic and rehabilitated mining areas, near the settlement, and in coastal habitats, than in rainforest. Rats became less common as red crabs became more abundant. It is possible that resource availability for rat populations on Christmas Island is limited by crabs and that rats fare better where competition and predation risks from crabs are lower. This suggests that removing the predation pressure of cats will not lead to a large increase in rats.

Using Parks Australia cat gut content data, we found that, on average, cats had eaten 0.64 rats per day (range of 0–2 rats per gut). Based on our rat population estimate for the island, average rat breeding rates, cat population estimates for the island and the rate of cat predation on rats, cats kill a small proportion of the rats born each year, and it is unlikely that cats are the main factor regulating rat populations. However, as rat populations vary depending on resource availability, cat predation pressure could suppress rat populations in some habitats but not others. Similarly, some habitats but not others could support a rat population increase.

Bird surveys showed that habitat, season and local crazy ant populations explained spatial variation in forest bird abundances better than rat activity did. There was no persuasive evidence that

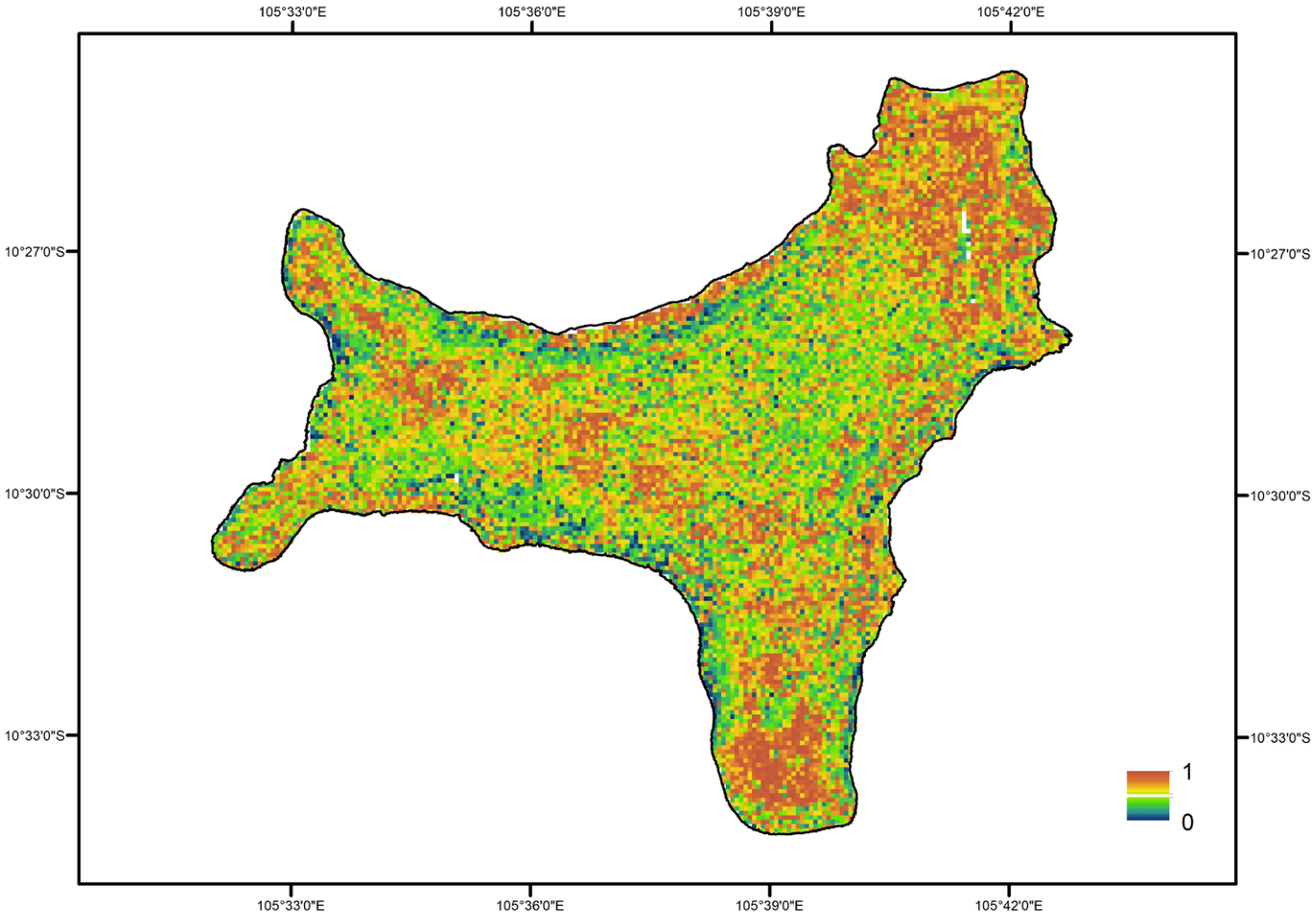


Figure 1: Spatial representation of rat abundance across Christmas Island. Rats are more abundant where habitat is drier, in disturbed habitats, and where crab abundance is lower. Red indicates areas with higher rat abundance of up to 32 rats per hectare.

Key findings (continued)

rats are currently significantly impacting thrush or tropicbird nesting success; rat predation occurred at a low rate for both species. Contrary to our expectations, rat density was significantly but positively related to thrush nesting success, while higher rat activity at red-tailed tropicbird nests and sites only slightly reduced their nesting success.

Before the cat control program began, cat predation was the most significant cause of nest failure for red-tailed tropicbirds. Cat control has reduced cat impacts and while there has been a slight increase of rat activity at nests, rat impacts on nesting success were, and remain, low.

Three percent of tropicbird nests failed through low levels of rat predation. Another 3% failed through goshawk predation, 14% due to nest abandonment, and several nests (17%) failed due to unknown causes. Nest failure from any cause begins to impact population persistence when failure rates reach 80%. If rat predation of nests increased above 40%, then that threshold would be reached. Rather than controlling rats, we consider that monitoring rat populations and rat impacts, and managing rats once bird nest failure thresholds are reached are better options.

We trialed different methods for monitoring rat populations and found that trap interference (such as crabs preventing the operation of traps) was higher for cage trapping and hair sampling (used to estimate density) than rat activity monitoring using ink cards.

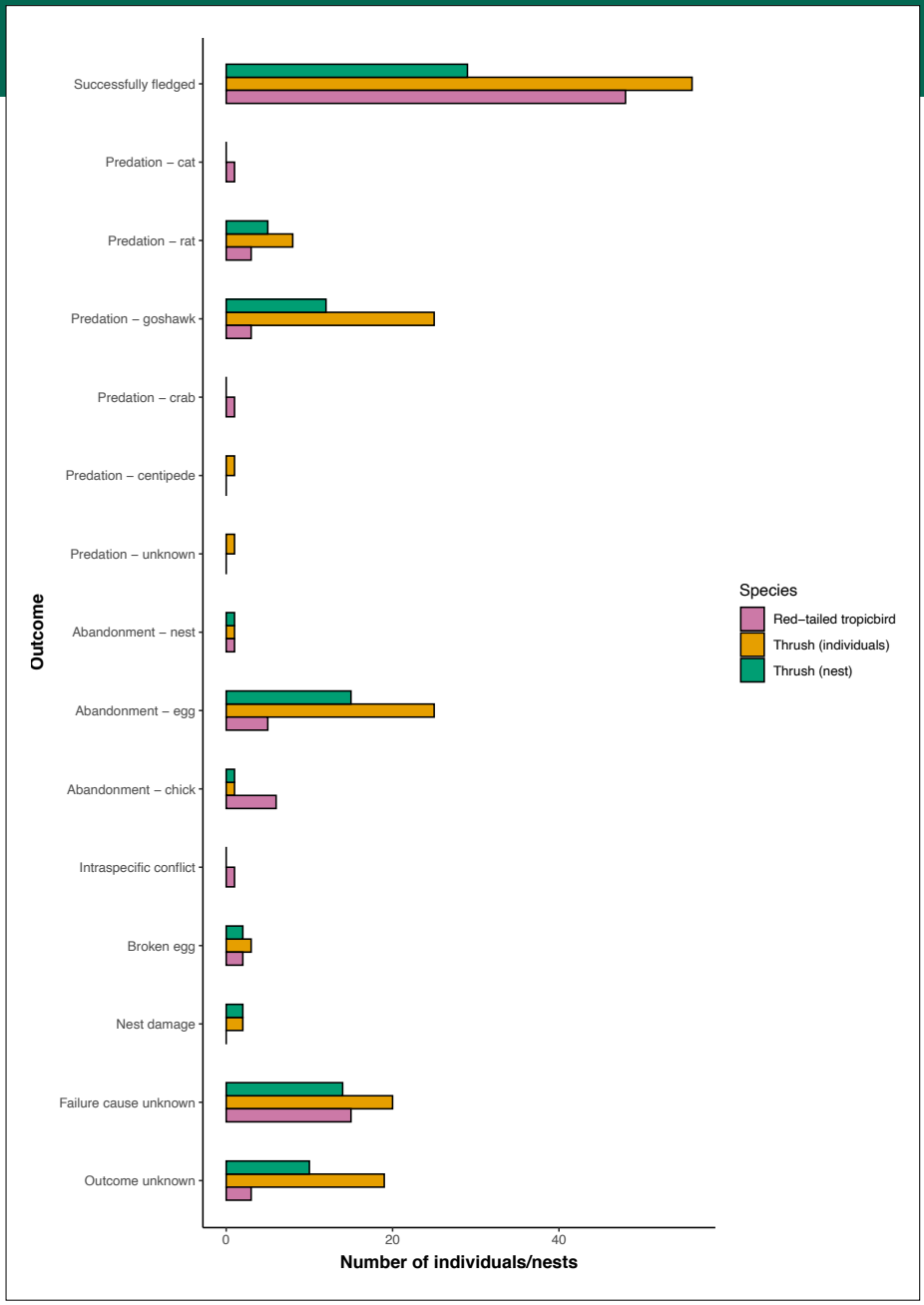


Figure 2: *Causes of nest failure for thrush and red-tailed tropicbirds monitored using nest cameras. Rats predate nestlings of both species but the rate at which this occurs is low for both species*

If crab activity/ interference increased and trap interference worsened, extra survey effort would be required to detect changes in rat populations.

Ink card monitoring provided the highest detection rates and is significantly cheaper than other methods tested. However, ink cards cannot be used to detect change in disturbed habitats where rat populations are very high, as ink cards become saturated with prints, so increases in rat activity could be missed. Moreover, if small changes in the rat population are important to detect, then density estimation methods, while more expensive, will be the only appropriate method to use. Whichever method is used, it would be wise to also monitor rat impacts at bird nests directly, as changes to rat density and activity will not necessarily relate to changes in their impact.

Research implications

Our findings are helping managers on Christmas Island by showing that the cat eradication program is unlikely to cause a significant increase in rat populations, and rat impacts on birds.

We have been able to recommend thresholds for rat impacts and rat population metrics that could be used as triggers for intervention action should rats reach levels where they are likely to impact the population persistence of the Christmas Island thrush and red-tailed tropicbird.

We have also recommended the best mix of monitoring methods to ensure that interventions are timely and appropriate.

The approach and findings developed in this study are of relevance to other ecosystems and eradication programs in which not all invasive species are eradicated simultaneously. In particular this study is of high relevance to informing eradication strategies on other islands where both cats and rats are present.

The hyper-abundant red crabs may both compete with, and predate on, rats. Image: Zoe Febicoski

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Cited material

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