Science for Saving Species

Research findings factsheet

Project 4.2.5

Threatened Species Recovery Hub

National Environmental Science Programme

Island invasions: Prioritising surveillance for cane toads on Kimberley islands

In brief

The protection of Kimberley islands from the threat of cane toads is important as they are home to many native animals that have suffered major declines on the mainland.

This is one of the first studies to examine the factors shaping cane toad invasions specifically on Australian islands. We used knowledge of cane toad ecology and movement pathways to create a model of cane toad invasion to islands off the Kimberley coast of far north-western Australia.

The model shows that natural methods of dispersal, such as rafting and swimming in freshwater pulses from nearby mainland rivers, are likely to be the main pathways for the arrival of cane toads to islands. Nevertheless, human visitation on islands and other human activity may also contribute to the arrival of cane toads on the islands.

Our findings ranked the likelihood of invasion by cane toads on 386 Kimberley islands over time until 2027, which can help land managers to prioritise their surveillance efforts.

Background

Australia's offshore islands are refuges for many native wildlife species that have experienced major declines and local extinctions on the mainland. Conservation managers are also increasingly using "island arks" as safe havens for populations of threatened species translocated from the mainland.

Representing roughly one-third of all of Australia's islands, the islands of the Kimberley are remote, largely uninhabited and almost free of invasive species. Almost all wildlife species that are unique to the Kimberley are present on the islands of the region, including all five mammals, at least 29 of 31 reptiles, at least six of seven frogs and 73 newly described island land snails.

Poisonous introduced cane toads (*Rhinella marina*) are now moving rapidly westwards across the Kimberley mainland. If they reach and establish on islands, it poses a threat to susceptible wildlife species that may be present. Adolphus Island, one of the most easterly islands in the Kimberley has already been invaded by cane toads.

The threat is especially great for native carnivores, such as the northern quoll (*Dasyurus hallucatus*) and several species of monitor lizard, which are often killed if they eat a cane toad.

Across northern Australia, these native carnivores have suffered steep declines and local extinctions that have coincided with arrival of cane toads.

Kimberley islands are likely to play an important role in protecting the future viability of the northern quoll if they can remain cane toad–free, first, because many islands support self-sustaining populations protected from many threats that are present on the mainland; and, second, due to the unique genetic diversity within the Kimberley island populations.

Our understanding of pathways of cane toad invasion onto islands is largely anecdotal, and includes records of: individual toads "hitch-hiking" on boats and other vehicles; toads arriving on islands by "rafting" on floating debris; and toads being washed to islands in freshwater "plumes" from mainland rivers, especially during very high flows. The invasion pathways may therefore be either natural or human-assisted.

Almost no Kimberley islands have people living on them permanently, though people do visit them.

Although a freshwater species, cane toads can tolerate some salinity for several days. If they reach an island, they need freshwater to reproduce.

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Background (continued)

The region has a tropical monsoon climate; very heavy rainfall and cyclones can occur between November and April causing freshwater flood pulses from river mouths, which can also carry debris that enables toads to raft.

Many islands are close to the mainland and are often near or within river mouths, which increases their vulnerability to invasion. Adolphus Island, which has already been invaded, is located in the mouth of a major river.

While it may not be possible to prevent individual toads reaching islands, eradicating invasions at a very early stage will reduce impacts to native wildlife and is more feasible and cost-effective than eradicating large and established invasions. Preventing cane toads from establishing on Kimberley islands will depend on targeted surveillance to detect new cane toad invasions.

Surveillance is expensive and there are around 2500 islands in the Kimberley region, but most of them are small and only 22 islands are larger than 10 km^2. Understanding how cane toads are likely to reach and spread across Kimberley islands and which islands are most at risk will help island managers to prioritise effort.

Research aim

We aimed to model complex information to make predictions about which Kimberley islands are most at risk of cane toad invasion over the next several years.

Varanus panoptes is a monitor susceptible to poisoning by cane toads. Image: Tricia Handasyde

What we did

We performed a desktop analysis to identify whether any broad features of Australian islands make them more or less vulnerable to cane toad invasion. We modelled the rate of invasion based on the effects of human activity, area, elevation, ruggedness, proximity to river mouths and river pulses, and time since mainland invasion, for which we had estimates. The paramaterised model was then applied to the Kimberley islands to predict future potential invasions of cane toads.

Northern quoll. Image: Lesley Gibson

Our modelling considered (1) safe transport for the toads across salt water (by two pathways – human-assisted transport, or rafting on debris or in freshwater pulses), and (2) the availability of fresh water on the island, which is necessary for toads to survive and reproduce.

Habitation on an island can be an indication that fresh water was available. We also assumed that freshwater availability is higher on larger islands and those that are more elevated, especially in the presence of rocky or rugged surfaces, as well as those with seeps and springs.

We assumed that the rate of people travelling to an island increases in proportion to how many people live there; the size of the island (bigger islands, more visitors); and how close the island is to the mainland (more visitors to closer islands).

We assumed that cane toads on rafts would be more likely to reach islands that are larger (as they are bigger targets) and that are closer to river mouths (as the journey is shorter), and if the river floods more often (as this gives the toads more chances). We also assumed that invasion of islands was more likely the longer a nearby mainland area had been invaded (more time and more chances).

Using data from historical cane toad invasions on Australian islands, we constructed a model to show how the toads would spread annually from the invasion front in the Kimberley and the probable sequence in which they would invade islands off the Kimberley coast.

Drawing on existing data that since their arrival in Kununurra in 2009 the toads are moving across the Kimberley mainland at a rate of around 45 km/year, we mapped anticipated invasion dates for the 10 years beyond 2017 for 386 Kimberley islands.

Cane toad. Image: Greg Schechter, CC BY 2.0 Flickr

Key findings

We found that islands nearest to the mouths of major permanent rivers on the mainland were the most likely to be invaded, and the likelihood of invasion increases over time once cane toads have invaded the nearby mainland. Island elevation also increased the risk of invasion.

Although they may present a bigger target and are more likely to have freshwater, the size of an island was not found to be an important factor influencing the likelihood of invasion.

Although almost all of the Kimberley islands are uninhabited, human-assisted movement via visitation may be a pathway for cane toad invasion, particularly given the large number of touring vessels in the Kimberley.

Our model predicted that by 2027, 95% of the islands (367/386) will have an up to 25% chance of invasion by cane toads, while 3% have a greater than 40% chance of invasion. Only the already-invaded Adolphus Island showed a greater than 50% probability.

Limitations and future work

We assumed that islands without detections of cane toads in the available databases were free of toads, but detection is likely to be imperfect, especially on islands that are more remote or inaccessible. However, future detections from repeat surveys of sites could be incorporated into the model.

Also, we modelled invasion at one rate over time, when it is more likely a two-stage process of initial incursion followed by persistence. More data about invasions could refine the model to show persistence depending on a number of invasions.

We used distance to the mouths of major permanent rivers as a predictor for rafting or travelling in a freshwater flood pulse.

An improvement would be to use a dynamic ocean circulation model, such as has been done for turtle hatchlings, but such a model is not yet available in appropriate detail for the Kimberley region.

Finally, the model assumes that all island invasions originate from the nearest mainland source, but in reality, cane toads may "island hop", especially as many islands are closer to each other than to the mainland. However, the invasion rate from island hopping may be less than that from the mainland, as islands don't experience river pulses that sweep toads into the ocean.

Future work will be useful in order to address these limitations and update the data of cane toad arrival in islands with new records.

Kimberley islands. Image: Mark Cowan

Implications and recommendations

Our preliminary findings can help land managers make more effective decisions about where to prioritise surveillance efforts for cane toads on Kimberley Islands.

Eleven of the Kimberley islands analysed are known to host populations of northern quolls, including the already-invaded Adolphus Island, while an additional four islands are at least suspected to host quolls. Of these, Koolan Island, which has a mining operation, has the greatest risk (47%) of cane toad invasion by 2027, followed by Boongaree Island (37%), Uwins Island (28%), Storr Island (23%) and Augustus Island (20%).

We recommend that land managers surveying Kimberley Islands for cane toads target those islands that are: 1) close to river mouths whose catchments are already invaded or newly invaded by cane toads; and 2) are more elevated. If it becomes difficult to decide which islands to choose, we offer a map with a ranking scheme, Figure 1 for a sub-set of islands.

Further analysis is warranted for how to optimise surveillance of islands, which explicitly considers the expected cost of eradication should a detection of the cane toads occur, the expected probability of success, and the expected cost of failing to detect or eradicate cane toads.

Islands are vulnerable to the combined threat of human-assisted introduction of cane toads and natural dispersal. Our results generally support previous research about island invasions, and the relative likelihoods of invasion that we have modelled can help cost-effectively defend Australia's vulnerable native fauna from cane toad invasion.

This modelling approach can also be adapted to optimise surveillance for the early detection of cane toad invasions on other Australian islands.

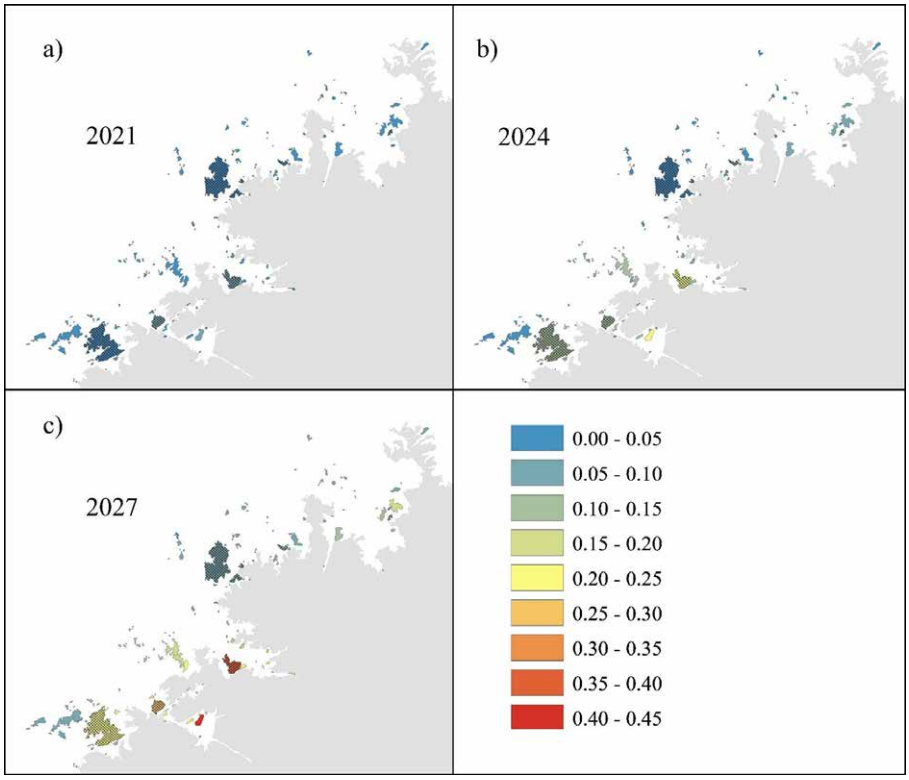

Figure 1. *The likelihood that cane toads will invade individual Kimberley islands by the years a) 2021, b) 2024 and c) 2027. Islands with known northern quoll populations are marked with crosshatch.*

Cited material

McKinney, M.R. (2019) *Ecology of biotic invasions on mainland Australia and its islands*. PhD thesis, The University of Queensland.

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Cite this publication as NESP Threatened Species Recovery Hub. 2021. Island invasions: Prioritising surveillance for cane toads on Kimberley islands, Project 4.2.5 Research findings factsheet.

This project is supported through funding from the Australian Government's National Environmental Science Program.