Controlling an Alien Invasion: The Truth is Out There…

Introduced alien cane toads have spread throughout North Eastern Australia over the past 75 years and have negatively impacted many populations of unique native species. New techniques are being investigated to limit such impacts by halting the cross-country spread of this unwelcome visitor. Pheromone manipulation in breeding pools may result in increased depredation and parasitism in juvenile toads. Limiting access to man-made water bodies in Australia's arid regions could be the key to maintaining toad-free ecosystems and stemming the cane toad flow.

The Problem…

Invasive alien species are 'non-native' introduced species which often out-compete indigenous taxa which have evolved in competition with each other. An invasive species is more likely to proliferate if it can exploit a novel resource in an ecosystem, to gain a competitive advantage. Such species are generally considered to be one of the top three major threats to global biodiversity along with habitat loss and climate change. They have the capacity to cause severe ecological, environmental and economic damage. For example, Invasive species cost the US government $138 billion annually in damage and management alone. If prices could be put on environmental health and loss of biodiversity, this figure would dramatically increase.

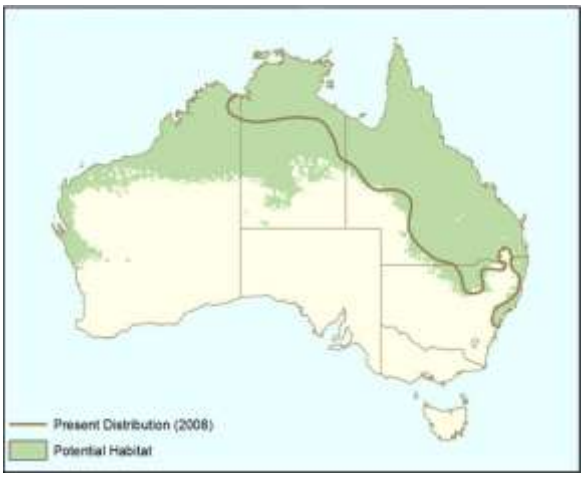
The Cane toad is the classic example of a highly invasive species, not least due to the fact that it was introduced to Australia by man, an increasingly common vector. 3000 toads were first released into the sugar cane fields of Northern Queensland in 1935. They were expected to help reduce cane beetles and increase sugar yield. Unfortunately, they ate a lot more besides their targets, and spread rapidly across the state. They have now colonised vast swathes of Northern and Eastern regions, and in 2009 were found for the first time in Australia's most western state. This species has had such a pronounced impact in Australia due to its fast reproduction, its generalist appetite, quick dispersal ability and the poisonous glands found on its back. Females lay between 8,000 and 35,000 eggs at a time and can produce two clutches each year.

The Cane Toad (Bufo marinus).

In the tropics, the toads can grow large and reach sexual maturity in a year, with recorded life-spans of around 5 years in the wild. They will spawn in almost any small water body and have therefore been able to spread quickly from their introduction site. Cane toads are true generalists and will eat anything from pet food to carrion and are therefore often found around human populations. Their main diet consists of almost every type of insect they encounter. This has been a problem for many indigenous insectivorous species as they are now in competition for prey items with this insatiable feeder. This is not the only threat they pose to other small insectivores, as cane toads have also been known to eat small amphibians, reptiles and mammals. Ground nesting animals are suffering from the toad's fondness of eggs and young. Both bird and turtle reproduction is reported to have been affected by predation in areas recently colonised by cane toads.

A key factor in the cane toad proliferation and devastation in Australia is the fact that they are poisonous. They therefore not only pose a risk to species small enough to be swallowed, but also those large enough to eat them. In their home range of Southern USA, Central America and tropical South America,

cane toad numbers are kept in check as they have natural predators adapted to avoid such poison glands.



Cane Toad range and suitable habitat in Australia.

The predators of Australia are naive to such dangers and would predate a cane toad as they would any indigenous amphibian. Amongst the predators affected there are snakes, lizards, crocodiles, dingos and quolls. Many of the species are known to die after eating a singular toad which demonstrates the strength of the toxin. Many of the affected predatory species, like much of Australia's wildlife, are endemic to these shores and are not found anywhere else in the wild. The associated decline in native populations could also have social effects for local people. Goannas have long provided a predictable source of bush-tucker to indigenous people in the out-back. Goannas are known to predate the toads and are susceptible to the toxin; population crashes could compromise livelihoods as well as traditional hunting techniques. No species extinctions have thus-far been linked to the invasion and there is evidence that some species are learning to avoid the toads. However the spread of these invaders increases the contact with naive species and the chances of irreversible ecological damage.

The Past…

Since the realisation of the toads huge ecological impact, a vast amount of effort and money has gone into eradication attempts. One of the biggest techniques employed so-far is the direct removal of cane toads by hand; there are numerous community groups in Australia committed to direct removal. In more recent times this has involved the capture and humane killing of cane toads, though this is not always the case. There are many stories of local control attempts concerning golf clubs and cricket bats. Last month a new aerosol product called 'Hop Stop' was released aimed at the market of concerned pet owners. The product is said to humanely kill cane toads with a spray in just one minute protecting cats and dogs from ingesting their deadly toxins. Cane toads crossing roads on mass in the breeding season often find themselves the targets of passing cars. Such actions are generally discouraged as there are some native frog species that can resemble the toads at certain life stages and these measures cannot discriminate. Direct removal may be useful for preserving particular threatened areas such as islands and are also more successful in the dry season. However, this requires huge effort and in the wet season when reproduction occurs this is not sustainable due to the rapid replenishment of populations. The majority of removal schemes are concentrated at the invasive front of the toads range. These areas have a constant supply of new individuals and it is hard to see how such management can have a lasting effect.

The Tiger Quoll; one of many marsupial species impacted by the Cane Toads.

The development and release of a virus to eradicate this alien is another idea that has been entertained for some time. The general

consensus is that this would be highly costly and considering the nature of the problem we are addressing, biological control should be a last resort if any! If the release of such a virus also managed to affect native amphibian species, it would no doubt cause more harm than the toads themselves. In recent times the emphasis for management has shifted as eradication appears ever less likely and control of spread is deemed more realistic. Some animal rights groups have also called for a more natural control of the toads than a cricket bat. The main target now is to stop the toads reaching and settling in the next million km^2 of ecologically unique Australian outback.

Gould's Goanna; one of 20 goanna species that would predate the toxic toads.

The Future…?

Research conducted into cane toad tadpoles has revealed that when one is attacked or stressed, a pheromone is released and nearby siblings flea the area. In outdoor experiments, the frequent addition of this pheromone to breeding pools keeps cane toad larvae stressed and doesn't appear to impact native tadpoles. This stress results in a higher death rate and smaller size and weight of emerging toad-lings. Reducing the size of toad-lings not only decreases their survival ability, it increases the window in which they are less toxic and available to certain native predators. Experiments where cat-food has been placed around breeding pools have increased the predation of young toads by aggressive meat-ants which are drawn to the area by the bait. Furthermore, parallel research has found that lungworms which greatly reduce lifespan and dispersal ability in cane toads are also not native to Australia. Professor Rick Shine of the University of Sydney stated "The worms are South American and do not parasitize native amphibians". These lungworms are known to be more fatal in younger, smaller cane toads. A combination of such pheromone, predatory and parasitic manipulation techniques at spawning sites could complement each other and reduce the number of toads reaching sexual maturity.

Some of the most promising research has recently been conducted by Dr Letnic from the University of Western Sydney and may prove invaluable on the frontline. Since their introduction the toads have invaded over one million km^2 from North Eastern Australia and are now beginning to spread into more central, arid regions. This latest control method hinges on using the cane toads weaknesses against them. The cane toads have enjoyed the lack of native toad competition, the naivety of their prey and predators and have exploited a novel niche in Australian ecosystems. However, the cane toads have not evolved with the hostile Australian climate and therefore have a weakness to target. Most Australian amphibians are adapted to cope with the long dry seasons of Northern Australia, and can last without water for prolonged periods of time. Cane toads require constant access to surface water which partly explains their occurrence in human landscapes. On the invasion front, toads are utilising the man made pools and dams set-up for cattle ranches to expand across the semi-arid regions of out-back.

Mass mortality has been observed in freshwater crocodiles at the invasion front due to predation of cane toads.

Dr Letnic and colleagues conducted exclusion experiments where man-made dams and water bodies were fenced-off to cane toads in the Victoria River catchment area of the Northern Territory. To monitor impacts, 25 of the cane toad inhabitants were radio tagged. Within three days, all of the tagged toads were found dead and there were still no cane toads found at the site a full two months later. Fencing-off year-round water bodies is viable in these semi-desert regions as they are irregular and man-made. Not all water-bodies would have to be fenced, just those on the outer-edge of the desert would prevent colonisation within. "If you can imagine a fire break, we can make a toad break," said Dr Letnic. The researcher also found there to be negligible effect on native fauna as larger creatures could still access the water and smaller natives are highly adapted to extended dry spells. It is predicted that fencing dams and raising cattle troughs in arid regions could reduce the total amount of Australia accessible to the toads by 38%. Furthermore, in arid areas already invaded by the toads, populations could be wiped out in just one dry season through such techniques.

The future is looking brighter for native Australian fauna as important findings continue to be made in the effort to control the spread of cane toads. Eradication is no longer an option and native wildlife will have to adapt to this invader where human intervention is not viable. In the meantime, we can all do our part to help stop the ecological impact of invasive species. Most introductions are accidental, and the best means of combating invasive species is to be vigilant when travelling, and adhere to border regulations.

If you are interested in further reading on the cane toad issue;

- http://www.canetoadsinoz.com

For more information on research into management through water exclusion;

- Florance *et al*. (2011) Excluding access to invasion hubs can contain the spread of an invasive vertebrate. *Proceedings of the Royal Society B; Biological Sciences* 00, 1-9.

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