THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Inquiry into controlling the spread of cane toads

House of Representatives Standing Committee on the Environment and Energy

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https://imb.uq.edu.au/canetoadchallenge
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This submission represents the opinions of the author. It does not necessarily represent an official position of The University of Queensland

Introduction

University of Queensland (UQ): For more than a century, UQ has maintained a global reputation for delivering knowledge leadership for a better world. The most prestigious and widely accepted rankings of world universities, consistently place UQ among the world's top universities. UQ research has global impact, delivered by an interdisciplinary research community of more than 1500 researchers across six faculties, eight research institutes and more than 100 research centres.

Institute for Molecular Bioscience (IMB): Formed in 2000 as an initiative of UQ, the Queensland State, and Australian Federal Governments, and private philanthropy, IMB has emerged as a global leader and one of the largest and most productive life sciences institutes in the Asia-Pacific region. Bringing together a community of researchers from across the globe, IMB research excellence and translational impact is underpinned by the quality of its staff and students, and its state-of-the art infrastructure and facilities.

Professor Rob Capon: Is a Professorial Research Fellow and Group Leader at the UQ, Institute for Molecular Bioscience, with over four decade's experience leading and advancing Australia scientific research. Prof Capon is a specialist in researching the chemistry of Australian biodiversity, including poisonous invasive plant and pest animal species, such as the cane toad. Prof Capon's research inspires innovative solutions to pressing problems in science, human and animal health, crop protection and the environment. His submission to this inquiry is informed by a history of cane toad related research and achievements, as summarized in Appendices 1 and 2.

Terms of reference

1. The effectiveness of control measures to limit the spread of cane toads in Australia

Before commenting on efficacy of cane toad control, it is important to clarify where the control is needed.

Many see the cane toad threat as narrowly focused at the invasion front, which is progressing west, traversing and expanding across the Northern Territory and Western Australia. While the invasion front is undoubtedly an area for concern, it is critical that we not ignore the cane toad invaded regions of Australia that trail behind the front, and reach back across the continent to the east coast of Australia (*i.e.,* Qld and northern NSW). This latter point cannot be stressed enough - ***there is an urgent need to support action both at the invasion front (i.e., out west) and within invaded urban and rural areas (i.e., back east)***, to address the environmental, social and commercial impact of cane toads across the whole nation.

Unfortunately, current cane toad control measures applied both west and east across Australia are of limited effectiveness, and are in urgent need of strategic investment, to both improve and validate, as well as educate and guide a coordinated implementation. While others will undoubtedly make claims to a range of approaches, I would like to focus this submission on two control measures – one that has stood the test of time (Toad Busting), and the other an innovative new approach that holds great potential (Tadpole Trapping). If implemented in a coordinated manner, these two measures could make a significant impact.

Toad Busting: This low technology and labor intensive approach consists of the hand capture and euthanasia of adult toads. Toad busting works best in populated open areas, such as parklands, ovals and roadsides, where toads are easy to spot and catch, and volunteers are ready and willing. Toad busting is far less effective in remote and under/unpopulated areas, or in heavily vegetated areas such as forests and wetlands, where toads are well hidden, on the ground capture is hazardous, and where it's harder to attract volunteers. Notwithstanding its capacity to bring communities together against a common foe (the toad), and despite dispatching many tens of thousands of adult toads each year, toad busting alone is not the answer. Cane toads reproduce at an astonishing rate, and with each new generation, toads that fall to toad busters are replaced, and the invasion continues. This is not to say that toad busting doesn't have its place, rather it needs to be coordinated with approaches that limit reproductive success, and inter-generational recruitment.

Tadpole Trapping: Many plant and animal species use specialized chemicals to enhance survival. These chemicals typically exhibit properties that are unique and beneficial to a single species – helping to locate food or prey, attracting a mate or prompting mating behavior, protecting against predators, or even guarding against infection. For example, knowledge of insect sex pheromones has been pivotal to developing effective measures for protecting commercial crops from all manner of insect pests. Equally, knowledge of cane toad chemical ecology has already delivered at least one promising cane toad control solution. Cane toad tadpoles are attracted to a chemical released by cane toad eggs. When extracted from dead adults, and used as an artificial bait, this chemical can attract many thousands of tadpoles into a funnel trap in only a few hours. Tadpole trapping was invented and patented by researchers at UQ and USyd, and is currently being rolled out to the public (see Appendix 2). Tadpole trapping is ideally suited for co-implementation with toad busting. Further investment in cane toad chemical ecology could yield additional cane toad population control measures.

Recommendation:

1. Any future investment in cane toad control should be mindful of the need to support efforts both at the invasion front (out west, WA & NT), and within the invaded territories (back east, Qld & NSW).

Terms of reference

2. Additional support for cane toad population control measures

The following comments are directed at two promising approaches in urgent need of additional support.

Improving existing measures (Toad Busting + Tadpole Trapping): There is an urgent need to better document, validate and coordinate a national best practice strategy for the well-established and the emerging practice of toad busting and tadpole trapping. This would extend to providing readily accessible and definitive advice (*i.e.,* web site, mobile device APP, help line) on where, when and how to bust and trap, as well as resources that explain how to identify all toad life stages (*i.e.,* eggs, tadpoles, juveniles and adults), best practice in humane euthanasia, safe handling and disposal, and data acquisition. Support could also extend to the supply of tadpole baits, as well as onsite visits to selected strategic areas, to assess and provide guidance on how to maximize impact and return on investment. Even a modest federal investment in professional support staff and resourcing, could attract dramatic dividends, by informing and empowering volunteers to be smarter and better at controlling cane toads. While the combo of toad busting plus tadpole trapping has capacity to play an even greater role, we need to be very clear that this is a stop gap measure. To deliver a lasting, national solution we need to discover and develop entirely new cane toad control measures.

Developing new measures (Chemical Ecology): There is an urgent need to support research into new and improved cane toad control measures. Cane toads are relentless invaders, that have mastered this skill over millions of years of evolution. If we are to have any hope of a long term, nationwide control solution, we need to look beyond hand capture, fences and barriers. My view is that it's imperative we focus our attention on methods that disrupt the reproductive cycle, and which suppress inter-generational recruitment. ***Put simply, we need to control future generations of toads, to safeguard the future of Australian wildlife.***

I propose significant, stable, multi-year funding of a multidisciplinary team of researchers, charged with exploring cane toad chemical ecology, to deliver one or more definitive and lasting cane toad control solutions. Chemical ecology has already delivered cane toad tadpole trapping, albeit delayed a decade due to the lack of resourcing. Imagine what could be achieved with a strategic commitment to funding and support. New chemical ecology-inspired cane toad control solutions offer hope, but our national capacity for prosecuting this area of science is very limited and on a knife edge, and without support is likely to fold entirely.

To win this war we need to be willing to roll the dice and support high risk but potentially high reward research. It's time to either invest and take the fight to the toad, or be upfront, accept defeat and walk away. If as a nation we elect not to invest, then we have no one to blame but ourselves.

Recommendations:

1. Invest in a nationally coordinated and integrated approach to improving, rolling out, monitoring and enhancing the wide-scale impact of toad busting and tadpole trapping.
2. Invest in research into cane toad chemical ecology, to discover the next generation of cane toad control measures, capable of being effective on a nation-wide scale.

Appendix 1

Key cane toad related milestones achieved by Prof Rob Capon and his team

2004: Prof Capon is commissioned by the CRC for Invasive Animals, and the Qld State Government, to carry out a proof-of-concept study, to investigate and report on past, current and possible future strategies for cane toad population control. This report highlights the need to invest in a better understanding of cane toad chemical ecology, to identify natural strategies for disrupting the reproduction/life cycle.

2012: Prof Capon and his team, together with colleagues at the USyd, file a patent, and publically disclose an innovative chemical ecology (pheromone) based cane toad tadpole trapping technology. This approach is immediately taken up by various "toad busting" community groups.

2015: Prof Capon and his team discover a pivotal natural protein (bufotoxin hydrolase, BtH) co-secreted with toad toxin, and used by the toad to amplify toxicity 100-fold. It is hypothesized that suppression of BtH offers a pathway to reducing the toxicity and environmental impact of cane toads in Australia.

2016: Prof Capon announces licensing of tadpole trapping technology to a US based pest control company.

Prof Capon presents at a Federal Department of Environment and Energy workshop in Darwin, participating in an update assessment of the "2011 - Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads".

Building on contacts made at that workshop, Prof Capon partners with researchers at the CSIRO Animal Health Laboratory to explore the genetics and biology of BtH, and its potential application in cane toad control.

2017: Together with other workshop participants, Prof Capon co-authors a seminal review on innovative approaches to cane toad control.

The Australian Patent Office awards UQ/USyd a patent on tadpole trapping, with Prof Capon as a co-inventor.

Prof Capon launches and is founding Director of the Cane Toad Challenge (CTC), a community engagement and citizen science initiative, dedicated to distributing cane toad tadpole trapping technology free to the public.

Prof Capon negotiates with and signs on > 50 organisations as CTC Affiliates, including Brisbane City, Ballina, Bundaberg, Gladstone, Logan, Ipswich, Tweed, Scenic Rim, Moreton Bay and Whitsunday councils, as well as Qld Parks & Wildlife, SEQ Water, various societies (*i.e.,* Qld Frog Society), schools, companies, pastoralists, environmental consultants, wildlife sanctuaries, golf courses, theme parks, retirement villages, multiple conservation and land-care groups, many large private land owners, and more. The response is overwhelming, as a volunteer workforce of many thousands commit to tadpole trapping.

Prof Capon embarks on an extensive program of public meetings across SE Qld and northern NSW, and countless radio, print media and TV interviews, to explain the science behind cane toad tadpole trapping.

Prof Capon delivers an invited international lecture on tadpole trapping and cane toad population control to the American Society of Pharmacognosy in Portland, Oregon, USA.

2018: Prof Capon delivers an invited lecture on tadpole trapping and cane toad population control to the International Society of Chemical Ecology in Budapest, Hungary, and to Maastrict University, Netherlands.

Prof Capon delivers an invited TedxBrisbane talk on cane toad tadpole trapping. Although <10 minutes duration, the talk captures the essence of the Australian cane toad challenge, and presents a positive and optimistic account of the discovery, development and successful community implementation of tadpole trapping. The script to the talk is provided in Appendix 2 to this submission.

Appendix 2

Tadpole trapping is currently being rolled out to the Australian public for free by the UQ Cane Toad Challenge (https://imb.uq.edu.au/canetoadchallenge). What follows is the script from a 2018 TedxBrisbane talk delivered by Prof Capon, on the Cane Toad Challenge.

Cane toads are relentless invaders.

Native to Central America, cane toads were transported to sugar cane growing regions of the world early last century, in the hope they would eat and eradicate beetles devastating sugar cane crops. This cane toad experiment held the promise of a cheap, permanent and self-sustaining solution to a commercial problem.

The experiment failed spectacularly. Cane toads showed no interest in the beetles, whatsoever, and instead launched a global invasion of epic proportion.

Cane toads reproduce at an astonishing rate, can eat just about anything, and are highly poisonous at all stages of their life cycle, as eggs, tadpoles and adults, poisoning and killing virtually all potential predators. The release of just 100 adult cane toads in Australia a mere 80 years ago, created the current situation, where 100's of millions of poisonous cane toads now occupy millions of square kilometers of Australia, devastating native species as they advance across the nation.

Cane toads poison and kill lizards, including large goannas. They even kill crocodiles.

Cane toads poison and kill snakes, including some of the most venomous in the animal kingdom. Even top tier predators are not immune to cane toads.

Cane toads poison and kill many furry native species, such as the northern Australian quoll, and other furry friends, such as dogs and cats.

For many years, the only option for reducing cane toad numbers has been hand capture of adults – known as Toad Busting. Despite dispatching many tens of thousands of toads, toad busting alone is not the answer. Each new generation of toads replenishes and builds on the last, and the invasion continues unabated.

In 2010 Time Magazine placed cane toads in the top three invasive species in the world. Cane toads truly are the Borg of the Animal Kingdom, and at times it does feel like Resistance is Futile.

We set out to develop a new, cane toad control solution – inspired by nature, and capable of working in parallel with Toad Busting.

We targeted a cane toad life stage that until now had been deemed untouchable. The Tadpole. Toad tadpoles are highly distinctive and easy to spot, emerging as black swarms of many thousands in the shallows of dams, creeks and backyard ponds, when the weather is wet and warm. When it comes to tadpoles, we know exactly where and when to look, and what to look for.

That cane toad tadpoles had not been targeted in the past was due to the fact they are almost impossible to catch by hand. There are far too many, and they are far too agile. Any attempt at hand netting risks disturbing fragile aquatic ecosystems and harming native species.

Some 2500 years ago a Chinese General wrote, "The supreme art of war is to subdue the enemy without fighting." Good Advice. If only we could subdue tadpoles without fighting, and without turning fragile aquatic ecosystems into battlefields. But how?

Ecologists had observed that toad tadpoles successful hunt and eat the eggs of other female cane toads. There are a number of possible reasons for this. Tadpoles may be hungry, in which case toad eggs are a nutritious snack. Tadpoles may be staking a territorial claim by eliminating genetic competition. Tadpoles may repurpose poison from eggs, for their own defense. More importantly, it was also noted that tadpoles are successful even in murky water with zero visibility. So, regardless of why tadpoles eat eggs, the important question for us was "How do tadpoles find eggs they can't even see"?

We discovered that toad tadpoles are drawn to a chemical attractant released by toad eggs. We isolated and identified this chemical. This was a Eureka moment. But before we could use the attractant to control tadpole behavior, to our advantage, we first had to dramatically increase our supply. We knew the attractant could be extracted from dead adult toads, but we were going to need a whole lot of toads.

We put out the call. The "bring out your dead " appeal worked, and we received hundreds of dead toad busted toads. These were processed in our lab, using an approach part CSI, part survivor and part mythbusters. We used a giant stainless steel blender to make toad smoothies, from which we extracted large amounts of tadpole attractant.

Next, we needed a way to deliver our attractant. The local pet store provided the answer, in the form of air stones, small porous stones about the size of a dice. Once painted with attractant, these stones became tadpole baits, known as BufoTabs.

Finally, we visited the local hardware store to get the materials to build a basic funnel trap. This consists of a simple plastic box, with plastic funnels inserted and glued into opposite sides. Funnel traps are cheap and easy to make.

We were ready. Our theory was, if we placed a BufoTab in a funnel trap, near a swarm of tadpoles, the tadpoles would follow the attractant scent into the trap. The theory worked. When placed in the shallows where toad tadpoles congregate, a single BufoTab in a funnel trap attracted and trapped several thousand tadpoles, in just a few hours. As a bonus, the attractant was highly selective for toad tadpoles, and did not attract frog tadpoles. Once trapped, toad tadpoles could be harvested, humanely euthanized, and disposed of safely.

To take the battle to the toad we created the Cane Toad Challenge, a not-for-profit, community engagement and citizen science initiative. We provide free BufoTabs and teach the public how to make and use their own traps. Although its early days, our tadpole trappers have already removed over a million poisonous tadpoles from local waterways.

It may have started locally, but the plan is to go national, and then global.

Join us. Trap Tadpoles and Turn Back the Toad Invasion.