THREATS TO NATURE

Case Studies in Success

TAMING A CACTUS

invasive species council

During the early 1900s prickly pear, advancing more than a thousand hectares a day, blanketed more than 20 million hectares of Queensland and northern New South Wales in a horror of spines. This case study explains how a devastating and seemingly intractable weed was tamed with the aid of a tiny moth from South America. This success was due to federal leadership, intergovernmental collaboration and a persistent, well-funded scientific endeavour.

THE PRICKLY PEAR THREAT

Prickly pear (*Opuntia stricta*) is an astonishing plant – tough, fecund and persistent – and one of the world's most devastating weeds. First reported in Australia in the 1830s, it was commonly planted as an ornamental or hedge plant.[1,2] Within 50 years, *The Queenslander* reported that the 'growing evil' of its spread on the Darling Downs was causing 'serious apprehension amongst stock owners'.[3] Attempts to burn or bury it were ineffectual.

By 1890, prickly pear covered 4 million hectares. By the mid-1920s, there were 24 million hectares and it was spreading a million hectares a year.[1,2] In parts, 'the dense growth was almost unbroken over many hundreds of square miles, with scarcely a habitation, a cultivated field or a head of cattle or sheep'.[2] Farming had to be abandoned over more than 10 million hectares.

ABATING THE PRICKLY PEAR THREAT

In 1901, the Australian Government offered a reward of £5000 (about $800,000 in today's terms) to anyone who could come up with a solution. Six years later the reward was doubled, but none of the 600–700 proposals was considered practical.[1] Ideas included mustard gas, flamethrowers and introducing more rabbits.

Prickly pear caused the abandonment of many farms. This home was in the Chinchilla district of Queensland. Photo: State Library of Queensland

Environmental harm was often exacerbated by containment and control methods. Birds were slaughtered in a vain attempt to limit the spread of prickly pear – a Queensland Government bounty for the destruction of emus, crows and currawongs was claimed for more than 300,000 birds between 1924 and 1928.[1] And vast areas were sprayed with poison – 3 million kilograms of arsenic pentoxide and sulfuric acid blends were applied from 1912 to 1932.[6] Chemical control often cost more than the land was worth (6–25 times more for heavy infestations) and rapid reinvasion was common.[1]

In 1912, the Queensland Prickly Pear Travelling Commission was formed to search for 'natural enemies' of prickly pear. A cochineal bug, *Dactylopius ceylonicus*, released in 1914, destroyed most stands of drooping prickly pear (*Opuntis vulgaris*), invasive in north Queensland, but was not effective on common prickly pear. These early biological control efforts were interrupted by World War I.

After the war, a much more concerted biocontrol program was launched with the formation of the Commonwealth Prickly Pear Board, jointly funded by the Australian, Queensland and New South Wales governments. Surveys in 15 countries from 1920 to 1935 resulted in the importation of 52 insect species for testing in Australia, including to make sure they did not attack native or commercially important plants, and 12 species were released.[1]

A moth, *Cactoblastis cactorum*, brought from Argentina in 1925, showed great promise. The first 10 million eggs were distributed in 1926-27, and by 1930 some 3 billion eggs had been delivered to landholders in a fleet of 7 trucks.[1,7] By eating the prickly pear flesh and triggering infections that rot the plant, about 2000 Cactoblastis larvae can

destroy a medium-sized prickly pear and 25 million can clear a hectare.[1,2] Another effective agent was the sap-sucking cochineal bug *Dactylopius opuntiae*, privately imported in 1921. It sold at times for up to £1 per infested segment (about $20,000 in today's terms).[1]

The moth and the bug were spectacularly successful – almost unbelievably so: 'mile after mile of heavy pear growth collapsing en masse and disappearing in the short space of a few years'.[2] The transformation from 'useless wilderness, choking pastoral and agricultural development, to a scene of prosperous endeavour [was] something akin to miraculous,' said a lead researcher.[8] In 1936, the Prickly Pear Land Commission declared in its annual report that the 'prickly pear menace has been overcome and the devastation it wrought a short ten years ago is now becoming merely a memory'.[1] At least 95% of the prickly pear in Queensland was gone by 1940.[2] It is still regarded as the world's most successful biological control program.

A fleet of seven trucks and 100 men delivered 3 billion cactoblastis larvae eggs.
Photo: Queensland Government Department of Agriculture and Fisheries

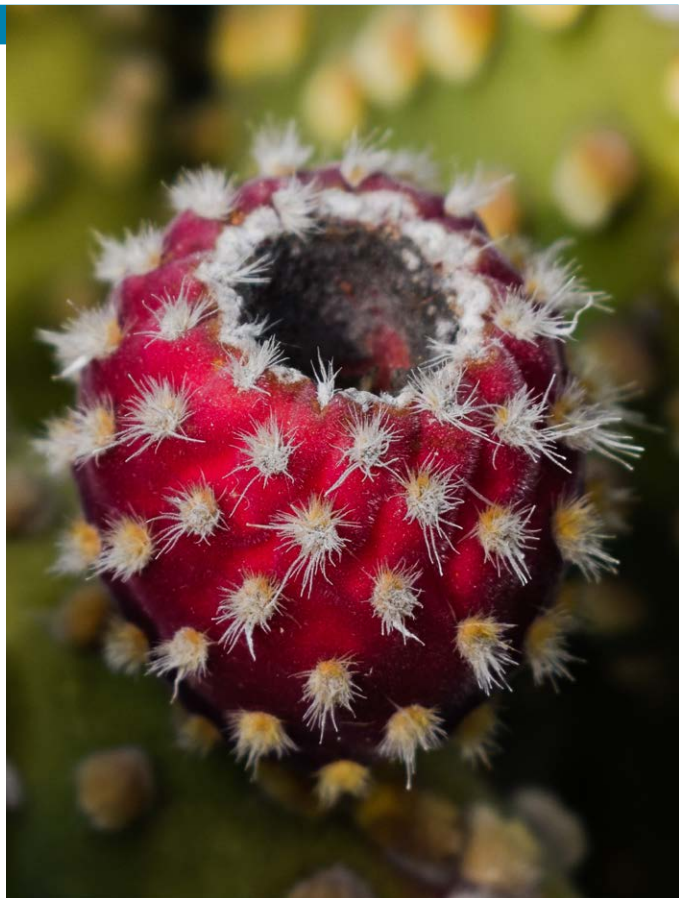
BOX 1

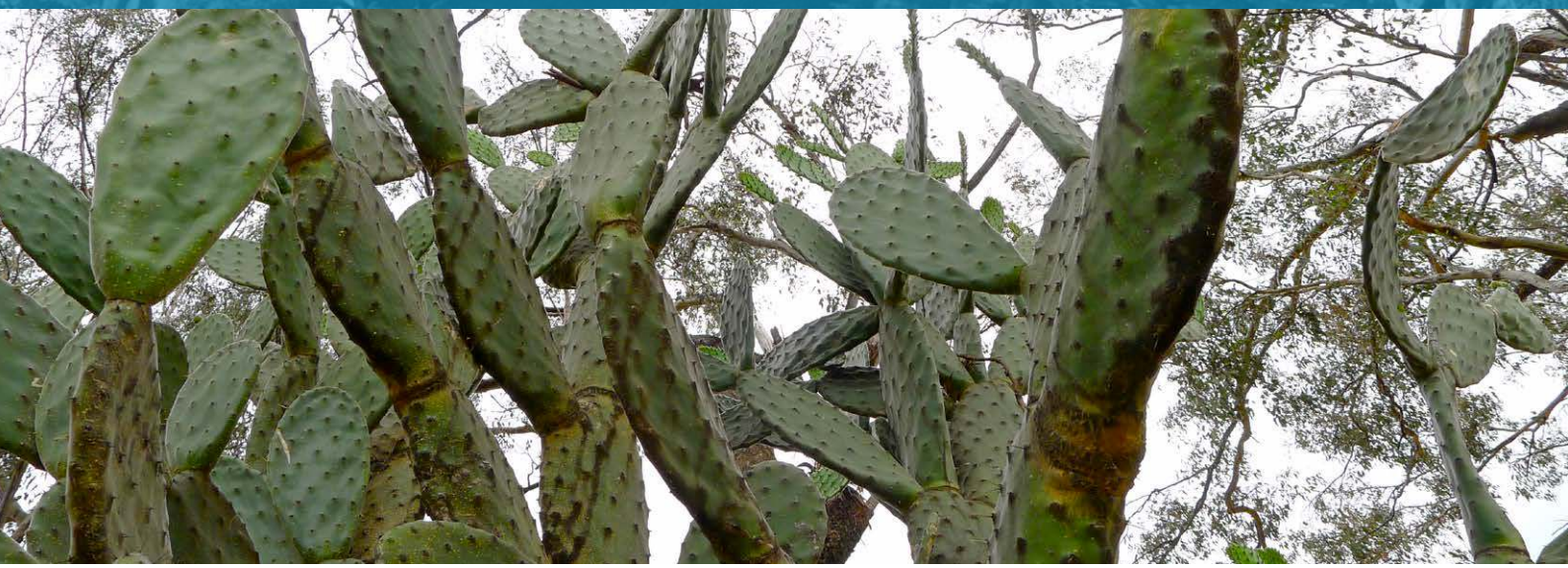
Why cacti are fearsome invaders

Cacti are superbly adapted to aridity. They store water in their thick leathery pads and stems, and practice crassulean acid metabolism, a method of photosynthesis that limits water loss by enabling carbon dioxide absorption and storage at night.[5] They are adept travellers, their seeds spread by birds that eat their succulent fruits, attached by spines to animals and machines and carried by floods. Scattered over the pads and fruit are numerous growing points (areoles) from which roots, flowers or pads can develop. These and other features make the opuntioid cacti extremely challenging weeds.

Opuntia stricta is only one of at least 27 weedy cactus species in Australia, many of which have the potential to invade vast areas of Australia.[4] The opuntioid cacti as a group (*Opuntia*, *Austrocylindropuntia* and *Cylindropuntia* species) were designated as weeds of national significance in 2012.

Prickly pear can survive, and often benefit from, drought, flood, fire, poison, grazing by stock and being chopped into hundreds of pieces. It can regenerate from roots, a fallen fruit or flower, a single pad that touches the ground, or a tiny portion of a pad, and seeds can survive in the soil for decades. No wonder it is one of the world's worst weeds.





The velvety tree pear (Opuntia tomentosa), invasive in eastern Australia, can grow up to 8 metres tall. Photo: John Tann | CC BY 2.0

THE ELEMENTS OF SUCCESS

Motivation, leadership and ambition: The loss of millions of hectares of prime agricultural land to prickly pear provided powerful motivation to find a solution. The involvement of Prime Minister Billy Hughes led to the establishment of the joint federal-state biological control program.

Collaboration between governments: The collaboration by the Australian, Queensland and New South Wales governments in establishing and jointly funding the Commonwealth Prickly Pear Board was a rarity in Australia's early political history.[6]

Financial commitment: The level of investment may be 'the best predictor of success for a biological control program'.[6] The Commonwealth program for prickly pear cost £240,000 (more than $900 million in today's dollars). About 30% was spent distributing billions of eggs to landholders, a major reason for the success of the program that has not been equalled in subsequent biocontrol efforts.[6] The proportion of Australia's GDP dedicated to the prickly pear problem far exceeds that subsequently allocated to all of Australia's weeds of national significance.[9] The economic benefits alone of the prickly pear program justified the expense: the capital value of the lands returned to productivity within five years of the Cactoblastis moth release was an estimated 42 times the program cost.[6]

The larvae of Cactoblastis cactorum are regarded as the world's most successful biocontrol agent.

Photo: Ignacio Baes, USDA Agricultural Research Service, Bugwood.org | CC BY-NC 3.0 US

Scientific research: In the mid-1920s, 'the checking of the onward march of prickly-pear, let alone the freeing from its octopus grip of the densely infested areas, appeared to be a hopeless task'.[8] Although the biological control program was expensive and required persistence over about two decades, it reaped massive enduring economic and environmental benefits. It proved the worth of investing in science. Unfortunately, important features of the prickly pear program – persistence, financial investment and intergovernmental collaboration – are rarely applied to other such threats today, making it hard to achieve equivalent success.[6]

WHERE WE ARE NOW

Prickly pear has not disappeared from Australia, but the Cactoblastis moth continues to suppress it in most places, for it can be sustained by one clump of prickly pear every hectare or so. However, the moth's effectiveness could be reduced as carbon dioxide levels in the atmosphere rise: experiments have shown that egg laying is substantially reduced and egg sticks are smaller under higher levels of CO_2.[10]

After its success in Australia, the Cactoblastis moth was introduced into other countries for prickly pear control. Unfortunately, it has also spread to the southern United States and Mexico, where it potentially threatens native cactus species.[11,12]

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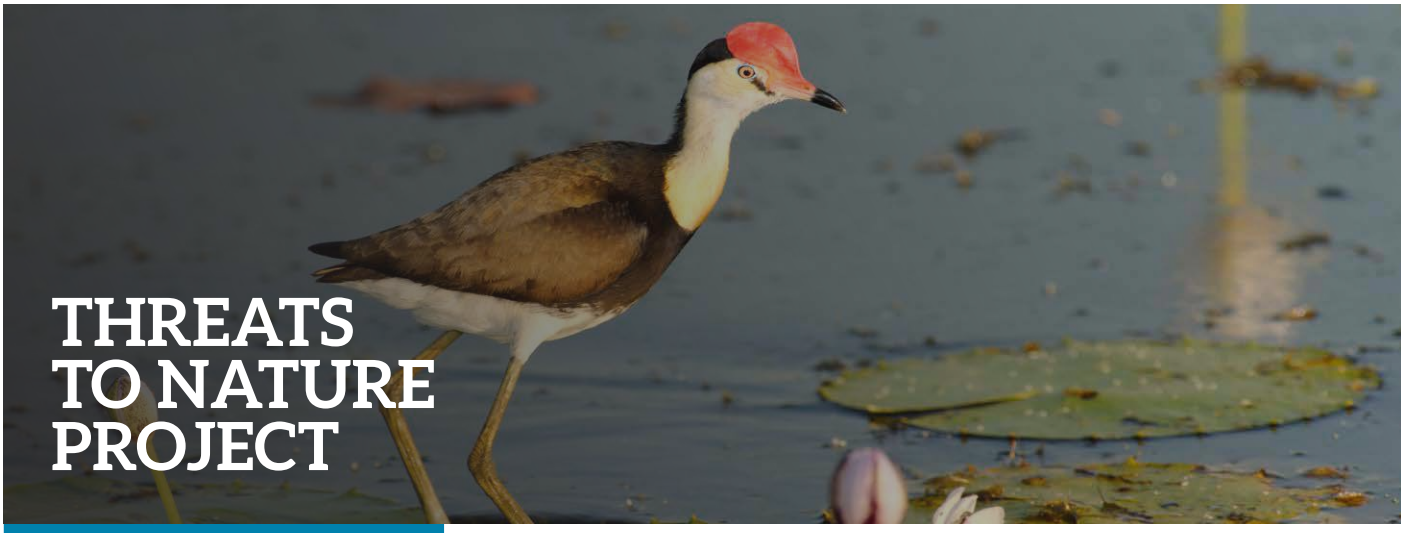
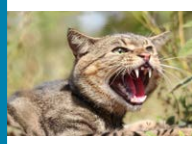


THREATS TO NATURE PROJECT

If Australians are to protect what is most distinctive about this country – our unique plants, animals and ecological communities – we urgently need to overcome the key threats facing them.





It is not possible to recover all of our threatened species one by one through species-focused efforts. We also need a concerted national focus to overcome the major threats our native plants and animals have in common – in particular **invasive species**, **climate change**, **habitat destruction**, **adverse fire regimes** and **changes to natural water flows**.

Australia's threat abatement system needs to be more ambitious, better funded and nationally coordinated.