GONE: Australian animals extinct since the 1960s

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invasive species council

Document details

Low T, Booth C. 2023. *GONE: Australian animals extinct since the 1960s.* Invasive Species Council Inc.

Design: Brett Iannello (Iannellodesign.com.au)

ISBN: 978-0-6488809-7-4

About the Invasive Species Council

The Invasive Species Council was formed in 2002 to advocate for stronger laws, policies and programs to keep biodiversity safe from weeds, feral animals, exotic pathogens and other invaders. It is a not-for-profit charitable organisation funded predominantly by donations from supporters and philanthropic organisations.

Acknowledgements

We acknowledge the First Australians and pay our respects to their Elders past and present. To stop extinctions in Australia will require harnessing the deep knowledge and land and sea management skills of Indigenous Australians and facilitating their meaningful involvement in decision-making.

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Introduction

Extinctions are holes torn in the fabric of life, and Australia is ragged from so many species ripped out. We are missing far more mammals than any other continent, as well as frogs, lizards, fishes, insects and plants. Many losses are recent.

As well as lamenting these losses, Australians should strive to understand why we have suffered so many. In this report, we examine the major drivers of extinctions, focused particularly on the causes of 'modern' extinctions. We profile each probable animal extinction since 1960. This includes species listed by Australian governments and others recently assessed by experts as likely to be gone.

Accounting for Australia's extinctions

Understanding past extinctions is vital for preventing new ones, but until a few years ago no one this century had comprehensively analysed Australia's extinction record. That was done in 2019 by scientists from the Threatened Species Recovery Hub, a consortium of universities and other bodies investigating endangerment and extinction.[1]

Ten biologists, led by John Woinarski, compiled a list of 100 extinct species recognised by an Australian government or the International Union for the Conservation of Nature (IUCN) and analysed the perils that brought them down.[2] Species that succumbed to multiple threats had these apportioned so that, for example, the thylacine had 70% of its demise attributed to hunting, 25% to land clearance and 5% to introduced disease.

The biologists concluded that land clearing had been the main cause of 36 extinctions. What was surprising was the larger number of extinctions, 45, caused by invasive species (introduced animals, plants and diseases). Hunting was the main cause of 6 extinctions, livestock grazing 4, modified hydrology 4, other ecosystem modifications 3. Climate change, fire and pollution had each caused one extinction. The patterns were clear:[3]

> Mammal extinctions were caused mainly by introduced predators; plant extinctions by habitat loss; frog extinctions by disease; reptile extinctions by an introduced snake; and invertebrate extinctions by a range of anthropogenic processes.

Land clearing is widely assumed to have been the leading cause of extinctions. After all, species need habitat, and huge tracts in Australia have been bulldozed or degraded. But the figures show that, even when grouped with livestock grazing as another form of habitat decline, habitat loss hasn't matched invasive species as an exterminating force. The conclusion holds true for extinctions in modern times: the Woinarski study listed 20 since 1960, 13 due mainly to invasive species.

There are clear reasons why this is so. Australia since European settlement has lost at least 33 (probably 34) mammal species, a toll blamed mainly on introduced cats and foxes.[4] The much larger continents of Asia, Africa, North and South America have, in total, lost only a few mammals (disregarding early extinctions blamed on spear-wielding hunter-gatherers).[5] Australia is the only continent other than Antarctica not to have native foxes and cats, and that surely explains the extreme difference.

Biologists often invoke the concept of prey naivety to explain why so many Australian marsupials and rodents succumb to foxes and cats.[6] These animals are adapted to native predators but the new carnivores operate differently. Cats have an ambush mode of hunting unlike that of native predators.[7] Over millions of years, various cat and fox species spread naturally through the other continents leaving Australia the only one whose mammals lacked familiarity with these predators. Cats have caused extinctions outside Australia, but only on islands that lack native cats.

The notion of naivety applies to most of Australia's animal extinctions. Frogs and native rats were immunologically naive towards introduced pathogens. Birds on Lord Howe Island were naive about the black rats that came ashore from a shipwreck, and Christmas Island animals were naive about wolf snakes. Naivety is a special issue for Australia, the most isolated of all continents, with so many species that stand out as different.

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[1] The Threatened Species Recovery Hub was funded for 6 years under the National Environmental Science Program, with matching funds from 10 universities and the Australian Wildlife Conservancy. Its work has added much to our understanding of the state of Australian biodiversity, and its demise in 2021 was a great loss.

[2] Woinarski et al. 2019. More recent evidence and analyses indicate that several of these 100 'extinct' species, including many of the plants (see Box 1), may not be or are not extinct, while several other animal species not on the list are probably extinct.

[3] Woinarski et al. 2019

[4] Woinarski et al. 2019, Garnett et al. 2022

[5] Loehle and Eschenbach 2012

[6] Carthey and Banks 2014, Moseby et al. 2015

[7] Woinarski et al. 2019b

The photographer of this northern tinker frog on Mt Lewis in north Queensland recalls hearing its beautiful call echoing at night through the rainforest. But the nights were quiet when he visited in 1989. It was gone from everywhere by the mid-1990s, succumbing to disease caused by chytrid fungus. Photo: © Martin Cohen

Modern extinctions

To promote better understanding of Australia's extinction toll, this report profiles every 'recent' extinction or likely extinction of animals, namely those lost since 1960. To do so, the Invasive Species Council updated the Recovery Hub's 2019 list by drawing on more-recent Recovery Hub assessments, which find that more animals but fewer plants are probably extinct than are formally listed.[8]

The differences between formal lists and expert assessments are due in part to the difficulty of being certain about extinctions and the risks of premature declarations (which could mean giving up on a species that can still be saved), as well as delays in listing processes. The changes are explained in Box 1.

The current toll since 1960 stands at 23 probable extinctions of animals and 4 of plants – averaging out at 4.5 extinctions a decade (Figure 1). Four of these (3 animals, 1 plant) are extinct in the wild (they survive in captivity or outside their native range).

The causes of 2 probable extinctions remain uncertain (although a pathogen is the only explanation suggested for one). Of the 25 extinctions for which causes have been assigned, 17 (68%) were due mainly to invasive species. Of the 21 probable animal extinctions, the proportion due mainly to invasive species is 81%. The 4 likely plant extinctions were due mainly to habitat destruction or degradation.

The invasive species causing recent extinctions have been pathogens or predators – chytrid fungus (6 extinctions), wolf snake (4), cat (4), fox (2), trypanosome (1), black rat (1), brown trout (1). Invasive extinction drivers have been diversifying: prior to the 1960s, the cat and fox were by far the greatest cause, with the black rat, rabbit and trypanosome each also responsible for a few.

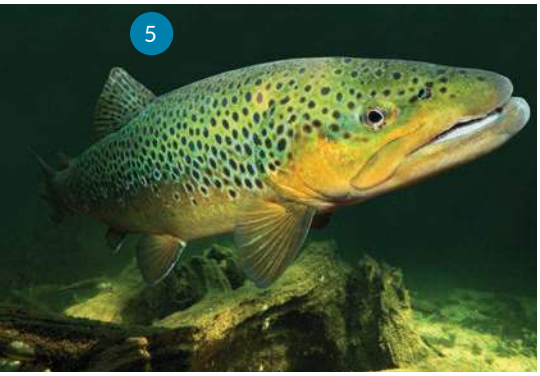
Of the 25 extinctions for which causes have been assigned, 17 (68%) were due mainly to invasive species.

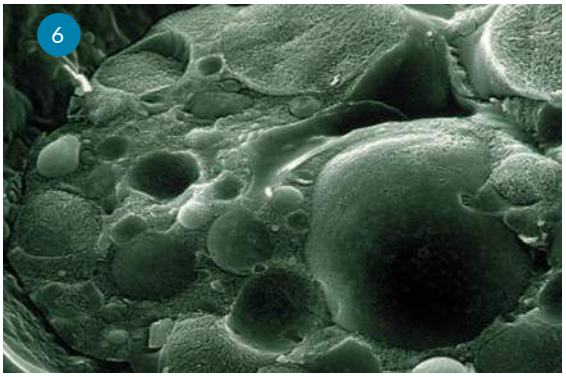
[8] Silcock et al. 2019, Chapple et al. 2019, Gillespie et al. 2020, Garnett and Baker 2020, Geyle et al. 2021, Garnett et al. 2022

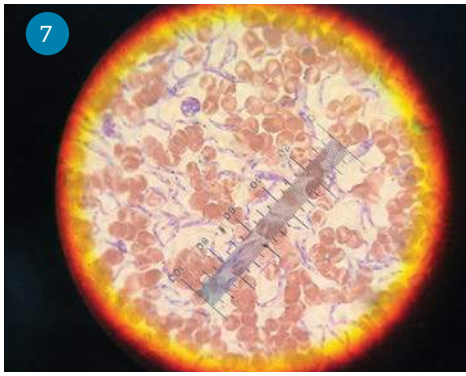
Invasive drivers of modern animal extinctions

1. Within about 20 years of arriving on Christmas Island as a ship stowaway, the wolf snake (native to Asia) wiped out a bat and 3 reptiles unique to the island. Photo: Thai National Parks

2. Feral cats have been a disaster for Australian wildlife – responsible for at least 25 mammal extinctions and imperilling more than 100 nationally listed threatened species. Photo: NT Department of Environment and Natural Resources
3. Introduced to Australia for recreational hunting, foxes have been responsible for the demise of at least 14 mammal species and imperil more than 60 nationally listed threatened species. Photo: Terry Spivey
4. Black rats have been one of the major drivers of loss on Australian islands – the main cause of at least 7 species extinctions (mainly birds) and a contributor to many others. They travelled on ships and may have first arrived with Dutch explorers in the 1600s. Photo: Nga Manu Images NZ







5. Introduced to Australia for sport fishing in the 1860s, brown trout, along with rainbow trout, have driven many small freshwater fishes to the brink of extinction. They are a serious threat to at least 22 fishes. Photo: adadonian/istock
6. The spread of chytrid fungus around the world has caused at least 90 frog extinctions, including at least 6 in Australia, and declines of hundreds of other frog species, including more than 20 under serious threat in Australia. Chytrid fungus damages the frog skin, leading to electrolyte imbalances and death by heart attack. Photo: Alex Hyatt, CSIRO Livestock Industries, Australian Animal Health Laboratory
7. *Trypanosoma lewisi*, a parasitic protozoan that probably arrived in Australia with black rats, is thought to have caused the demise of 2 native rats and a shrew on Christmas Island. There is speculation that it also contributed to the extinction of mammals on mainland Australia. Photo: Sarazeidan

PRIMARY CAUSE OF EXTINCTION

Decade of last record	Invasive species	Habitat destruction or degradation	Altered hydrology	Climate change	Uncertain
1960s	Yallara (*Macrotis leucura*)	Victorian grassland earless dragon (*Tympanocryptis pinguicolla*) (87%)			
	Central hare-wallaby (*Lagorchestes asomatus*)	Divided darwinia (*Darwinia divisa*)			
1970s	Desert bandicoot (*Perameles eremiana*)		Lake Pedder earthworm (*Hypolimnus pedderensis*)		Kuchling's long-necked turtle (*Chelodina kuchlingi*)
	Southern day frog (*Taudactylus diurnus*)				
1980s	Southern gastric brooding frog (*Rheobatrachus silus*)	Lyon's grassland striped skink (*Austroablepharus barrylyoni*) (77%)			
	Northern gastric brooding frog (*Rheobatrachus vitellinus*)				
	Gravel-downs ctenotus (*Ctenotus serotinus*) (72%)				
	Christmas Island shrew (*Crocidura trichura*) (92%)				
1990s	Mountain mist frog (*Litoria nyakalensis*) (85%, 93%)	Nielsen Park she-oak (*Allocasuarina portuensis*)*			Kangaroo River Macquarie perch (*Macquaria* sp.) (89%)
	Sharp-snouted day frog (*Taudactylus acutirostris*)				
	Pedder galaxias (*Galaxias pedderensis*)*				
2000s	Northern tinker frog (*Taudactylus rheophilus*) (86%, 90%)	Cronin's tetratheca (*Tetratheca fasciculata*)	Wingecarribee gentian (*Gentiana wingecarribiensis*)	Bramble Cay melomys (*Melomys rubicola*)	
	White-chested white-eye (*Zosterops albogularis*)				
	Christmas Island pipistrelle (*Pipistrellus murrayi*)				
2010s	Christmas Island forest skink (*Emoia nativitatis*)				
	Blue-tailed skink (*Cryptoblepharus egeriae*)*				
	Lister's gecko (*Lepidodactylus listeri*)*				

Figure 1. Probable animal and plant extinctions since 1960

Notes: * indicates species that are 'extinct in the wild', meaning they are extinct in their native range but survive in captivity and/or as translocated populations. The percentages in brackets apply to species not listed by Australian governments as extinct but which have been assessed by experts as likely to be extinct (the % is the assessed likelihood). This is explained in Box 1.

Box 1. Explaining the extinction list

Extinction lists are dynamic. We amended the list in the 2019 Recovery Hub paper by Woinarski and colleagues by removing and adding species to create a current list of probable extinctions since 1960. There is often some degree of uncertainty about recent claimed extinctions, particularly of plants, so we emphasise that the species noted as likely extinct in our list should be regarded as just that until formal assessments have been done.

Animals removed from the list

- Whitley's tapered snail (*Bothriembryon whitleyi*) – relatively fresh shells have been found, suggesting this species may survive.[9]

Animals added to the list

- Central hare-wallaby (*Lagorchestes asomatus*) – the Recovery Hub paper listed this as last recorded in the 1950s, but Pintupi informants interviewed by Andrew Burbidge and colleagues said it survived in the Gibson Desert until at least 1960.[10]

In a 2022 Recovery Hub paper, Stephen Garnett and 9 other experts rated the following species as likely to be extinct.[11] We have included those rated as having at least a 70% likelihood of being extinct. The second rating for the 2 frogs comes from a separate Recovery Hub paper.[12]

- Christmas Island shrew (*Crocidura trichura*) (92% likelihood)
- Victorian grassland earless dragon (*Tympanocryptis pinguicula*) (87%)
- Kuchling's long-necked turtle (*Chelodina kuchlingi*) (70%)
- Lyon's grassland striped skink (*Austroablepharus barrylyoni*) (77%)
- Gravel-downs ctenotus (*Ctenotus serotinus*) (72%)
- Mountain mist frog (*Litoria nyakalensis*) (85%, 93%)
- Northern tinker frog (*Taudactylus rheophilus*) (86%, 90%)
- Kangaroo River Macquarie perch (*Macquaria* sp.) (89%)

The yellow-spotted bell frog (*Litoria castanea*) was also rated as likely to be extinct (74%), due mainly to chytrid fungus, but we excluded it because of doubts about its validity as a species.[13]

Plants

We have not profiled the 4 recently extinct plants, but they are included in Figure 1 and in calculations of extinctions by cause. Plants are a difficult category because species declared extinct often do not stay that way. A 2004 study of plants designated extinct by the Australian Government or CSIRO found that 167 out of the 228 species listed at one time or another were subsequently deleted from the list, most often because they were rediscovered, and sometimes because they proved to be invalid species.[14] Since 2000, at least 24 'extinct' plants have either been rediscovered or their status as a species has been questioned.[15]

Threatened species lists are dominated by plants, whose large numbers result in very little search effort for some missing species, far less than has been expended on the animal species featured here. Plants often have persistent seedbanks, which means that a species can be absent as a plant, but survive in the soil as seeds, sometimes for decades, awaiting fire or some other germination cue. Animals are occasionally removed from extinction lists but at much lower rates.

Cognisant of these issues, 4 Recovery Hub botanists led by Jen Silcock reviewed 'extinct' plants (those listed by an Australian government) and decided that Australia has 2 species that are almost certainly extinct, 10 probably extinct, 20 possibly extinct, and 17 possibly extant.[16] They concluded that 3 of 7 'extinct' species last recorded in the wild since 1960 have not been searched for thoroughly, so declarations of their extinction are premature. We removed these from consideration here.

9 Whisson et al. 2017
10 Burbidge et al. 1988
11 Garnett et al. 2022
12 Geyle et al. 2021
13 Threatened Species Scientific Committee 2017
14 Keith and Burgman 2004
15 Silcock et al. 2019
16 Silcock et al. 2019

"Christmas Island is … a 21st century extinction hotspot."

John Woinarski (2018)

Five of the 7 known extinctions on Australian islands since 1960 have been on Christmas Island. Boasting more endemic species than any mainland part of Australia of similar size, its wildlife has been besieged by invasive wolf snakes, giant centipedes, yellow crazy ants and a parasite carried by black rats. Starting with 4 mammals and 6 reptiles, it is now down to 1 mammal (a critically endangered flying-fox) and 1 or 2 reptiles. Photo: © Tim Low

Imminent extinctions

The past is said to be the best guide to the future, and if that holds true, invasive species will remain the main cause of extinction in coming years. Australia has 22 fish species very close to extinction, 14 of which are galaxias, for which, according to one Recovery Hub paper, introduced trout pose the greatest risk.[17] The 4 species of frog most likely to slip away have Asian chytrid fungus as their prime problem.[18] A Recovery Hub review of lizards and snakes close to extinction identified invasive species as the most prevalent threat.[19]

Myrtle rust, a plant disease detected in 2010, has become the latest invasive species capable of eliminating species. Three botanists who surveyed plants across Queensland and New South Wales declared 16 to be at imminent risk of extinction from this disease.[20] Urgent steps have been taken to save many of these by collecting seeds or using cryotechnology to conserve tissues.

If greenhouse gas emissions aren't curbed, climate change will become a major force of extinction. After warming by 1.47°C since 1910, Australia has lost one species to date – the Bramble Cay melomys.[21] This species was exceptionally vulnerable to rising sea levels, confined as it was to a low island less than a tenth of a square kilometre in area.

The scarcity of climate change extinctions thus far may indicate inherent adaptability that reflects warming in Australia's 'recent' past. There is coral and fossil pollen evidence for temperatures about as warm as those of today during the last interglacial, 130,000–120,000 years ago, and during the Holocene Climatic Optimum about 5,000 years ago.[22] The species at greatest risk from climate change are often considered to be those on mountain summits, and they must have survived these warm periods in situ, having nowhere cooler to go to. Climate change is rated by experts as the second most important threat (after chytrid fungus) to Australia's most endangered frogs, and a threat to most of the 22 fish and 13 of 55 plant species at high risk of imminent extinction.[23]

Extreme bushfires influenced by climate change could become a new force of extinction. A Recovery Hub paper on the 2019–20 bushfires concluded that about 100 severely impacted animal species should be newly listed as threatened or upgraded to a higher level of threat.[24] For some of these species, fire and invasive species are connected liabilities. Small mammals that survive a fire are very vulnerable to foxes and cats hunting in the bare landscapes, and galaxias facing siltation of streams from bared slopes are also at serious risk from trout. Twenty-two species of spiny crayfish (*Euastacus* species) warrant listing as threatened because of those fires, and they could face devastation from crayfish plague (*Aphanomyces astaci)* if this pathogen reaches Australia on smuggled pet crayfish (Box 2).[25]

17 Lintermans et al. 2021
18 Geyle et al. 2021a, Gillespie et al. 2020
19 Geyle et al. 2020
20 Fensham et al. 2021
21 Bureau of Meteorology 2023, Gynther et al. 2016
22 Reeves et al. 2013, Byrne et al. 2008
23 Gillespie et al. 2020, Lintermans et al. 2021, Silcock and Fensham 2018
24 Legge et al. 2022
25 Legge et al. 2022

A recent arrival in Australia, myrtle rust could be the next major driver of extinctions. When detected in 2010, it was subject to a failed eradication attempt. Already, 16 plant species are on the verge of extinction and several others are in trouble. Photo: © Tim Low

Land-clearing is ongoing, and expected to cause further extinctions, of plants in particular. Of 50 plants considered at high risk of imminent extinction in the Recovery Hub's *Action Plan for Australia's Imperilled Plants*, 6 are most threatened by habitat loss.[26] A larger number (10 species) have pathogens (myrtle rust, Phytophthora) as their main problem, but the numbers take no account of past clearing having left many plants in pitifully small numbers, often lingering on roadsides, where they are highly vulnerable to inbreeding, roadside disturbances, weed invasion, Phytophthora, and unfavourable fire regimes.

No more extinctions?

Modern laws and sensibilities have not stopped extinctions. The rate appears to be accelerating, with at least 9 probable losses since the turn of the century, 6 of those from invasive species (wolf snakes, rats, chytrid fungus), and another 100 or so species assessed as having a high risk of extinction within 10 to 20 years.[27] Australia is one of the world's wealthiest countries, with excellent scientific expertise and a mostly caring populace. We have no excuse for extinctions. Yet they keep happening.

The Australian Government recently declared 'no more'. 'I will not ... accept environmental decline and extinction as inevitable,' said Environment Minister Tanya Plibersek in October 2022 when she launched the *Threatened Species Action Plan*. That ambition to stop extinctions is an essential part of the solution.

Other essential elements are also conceptually straightforward – better border biosecurity, systematic threat abatement and threatened species recovery programs, and a joint commitment by all federal, state and territory governments, backed by adequate funding.

As the Invasive Species Council notes in *Averting Extinctions*, its report on improving threat abatement, 'Australia appears to be the only country with a threat abatement system enshrined in national law.'[28] But it has been a low priority for a succession of governments and starved of funding. Many threats are not listed and many threat abatement plans are either not made or are poorly enacted.

Anyone who cares deeply about extinctions should take an interest in biosecurity. Chytrid fungus, responsible for 6 extinctions so far, slipped into Australia in the 1970s; wolf snakes, responsible for 4, reached Christmas Island in about 1987; and myrtle rust appeared in 2010.[29]

Pathogens with the potential to cause future extinctions if they reach Australia include the crayfish plague agent (*Aphanomyces astaci*) (Box 2), frog ranaviruses, high pathogenicity bird flu (H5), additional strains of myrtle rust, other plant pathogens such as *Ceratocystis*, and a fungus, *Pseudogymnoascus destructans*, which has killed vast numbers of American bats.

Cane toads have pushed some native animals onto endangered lists and a second invasive toad species, the black-spined toad (*Duttaphrynus melanostictus*), has good chances of establishing unless biosecurity improves. Since 2000 it has been intercepted at Australian ports on more than 80 occasions and beyond the border more than 24 times, hopping free in Sydney, Melbourne, Adelaide and Perth.[30] The interceptions at ports show biosecurity working as it should while finds beyond them count as failures that put Australia's wildlife at risk. Another 4 species of toad have been intercepted in recent years at ports.[31]

[26] Silcock et al. 2021
[27] Silcock et al. 2018, Geyle et al. 2018, Geyle et al. 2020, Lintermans et al. 2021, Geyle et al. 2021, Fensham and Radford-Smith 2021, Garnett et al. 2022
[28] Threats to Nature project 2022
[29] Smith 1988, Berger et al. 2009, Carnegie and Pegg 2018
[30] Tingley et al. 2018. This does not include data from the last several years, so the numbers are likely to be considerably higher now.
[31] Tingley et al. 2018

Box 2. A looming risk for crayfish

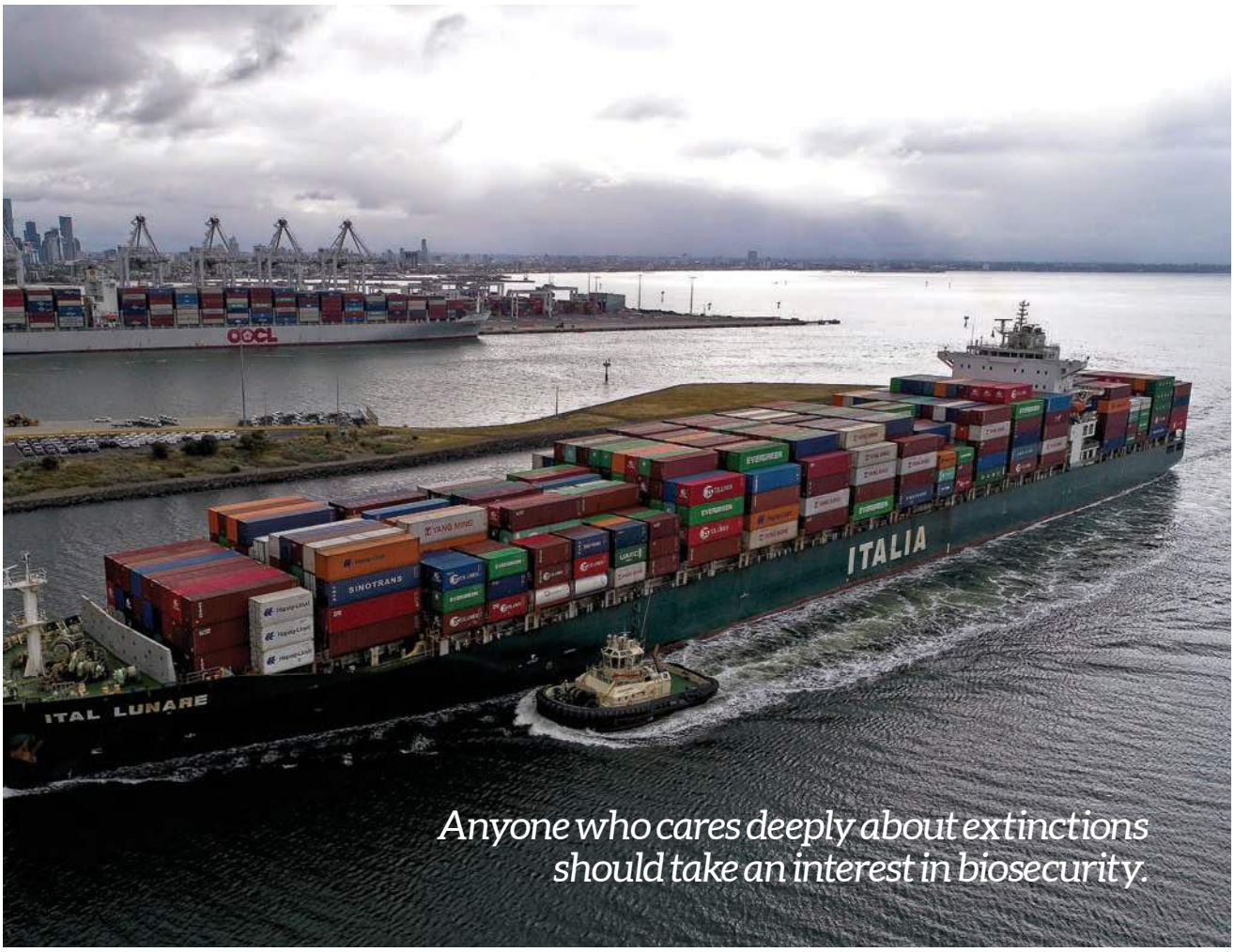
With about 140 species, Australia has the world's richest freshwater crayfish fauna after North America. We haven't suffered any crayfish extinctions, but that could change dramatically if infected pet crayfish are smuggled into the country.

Laboratory tests and farm deaths have shown that Australian species are highly vulnerable to crayfish plague, caused by a water mould native to North America[32] and spreading in Europe and Asia.[33] The Department of Agriculture has warned that this pathogen has 'the potential to cause almost 100% mortality in farmed and wild crayfish in Australia'.[34] In 2013 it appeared in Taiwan and killed all the Australian redclaw crayfish (*Cherax quadricarinatus*) in 4 farms. It advanced much closer to Australia when it appeared in a pet shop in Bogor, Indonesia, in 2018.[35] In Europe it has caused catastrophic declines in the wild – the noble crayfish that once dominated Europe's waters is now threatened, and the white-clawed crayfish, once plentiful in England, is endangered.[36]

In 2016, illegally imported Mexican dwarf crayfish were selling openly in Australia on Gumtree.[37]

The Lamington spiny crayfish (*Euastacus sulcatus*) could be sent extinct by a combination of crayfish plague, rising temperatures, and severe bushfires silting streams. Photo: © Bruce Thomson

[32] Van Der Wal et al. 2023
[33] Svoboda et al. 2017
[34] Department of Agriculture, Water and the Environment 2019
[35] Putra et al. 2018
[36] As listed on the IUCN Red List
[37] McCormack 2016



The next wave of extinctions could come from a pathogen arriving on a small animal that hitched a ride on a cargo ship.
Photo: © Owen Foley

These pathogens and toads remain unknown to most Australians. There is more public awareness about diseases and pests that threaten agriculture, such as foot and mouth disease and the recently arrived varroa mite. It was only in 2020 that priority risks for the environment were identified.[38] And while much effort has gone into trying to stop the entry of new crop and livestock pests and diseases, there are as yet few biosecurity plans focused on high priority environmental risks. While failed biosecurity for agriculture represents financial losses, for the environment it can mean more extinctions.

With Minister Plibersek's intention to rewrite Australia's national environmental law, we have an opportunity to strengthen conservation planning and environmental regulation. But a new law will be for nought unless governments demonstrate genuine commitment by increasing conservation funding. According to one credible estimate, this needs to increase by an order of magnitude, to at least $1.5–2 billion a year.[39] Border biosecurity needs more funding as well. One telling indicator is that Australia has only 46 sniffer dogs at the border today compared to 80 in 2012, despite increasing trade.[40]

We have no doubt that most Australians would want more of their taxes going to stop extinctions. We hope the recent losses documented in the following pages will strengthen Australians' determination to save species and help persuade our governments to invest much more in biosecurity and environmental protection.

[38] ABARES 2020
[39] Wintle et al. 2019
[40] Sullivan 2023

EXTINCTION PROFILES

Yallara, lesser bilby
(*Macrotis leucura*)

Pleas to save the bilby sadly came too late for one species – the lesser bilby or yallara. It was last sighted by a scientist in the 1930s, while Aboriginal people recalled them surviving until the 1960s.

In 1931, a Wangkangurru man showed amateur scientist Hedley Finlayson these animals at Koonchera Dune on the edge of Sturt Stony Desert in South Australia. His guide was adept at excavating their winding burrows dug into steep dunes. Finlayson vividly described the captured yallara:

> The animals completely belied their delicate appearance by proving themselves fierce and intractable, and repulsed the most tactful attempts to handle them by repeated savage snapping bites and harsh hissing sounds...

EXTINCT

Primary Cause
INVASIVE SPECIES

1960s

In the early 1980s, biologist Andrew Burbidge and 3 colleagues visited almost 50 desert communities across a vast swath of outback on an urgent mission to record information about extinct species. With interpreters and museum skins they asked elders about their desert mammals past and present. Lesser bilbies were remembered in many communities by elders who had not seen them for as long as 60 years. The freshest memories came from Pintupi people who had seen them 20 years previously in hills near today's settlement of Patjarr in the Gibson Desert of Western Australia. The Pintupi of this region were some of the last Aboriginal people to encounter white Australians, and their recollections imply that this species, which they knew as nantakarra, nyunpi or tjunpi, went extinct in the 1960s.

Foxes and cats are blamed for the extinction of this small bilby species.

Formal national status	Extinct
Expert assessment of extinction causes	Cat 60%, fox 25% (Woinarski et al. 2019)

Main sources: Burbidge et al 1988, Finlayson 1935, Van Dyck and Strahan 2008; Woinarski et al. 2014

Image: Oldfield Thomas

Of the central hare-wallaby nothing more tangible survives than one skull.

The only physical clue to the central hare-wallaby is this skull found in the Northern Territory, but we know from Aboriginal testimony that the species also occurred in Western Australia, including in the Kiwirrkurra Indigenous Protected Area, shown here. Photo: © Robert Whyte. Inset: © South Australian Museum

Central hare-wallaby, kuluwarri

(*Lagorchestes asomatus*)

Of the central hare-wallaby nothing more tangible survives than one skull from an animal killed in the Great Sandy Desert in 1932. The skull was submitted by Michael Terry, a geologist-explorer who provided no information about it other than a vague locality (somewhere between Mount Farewell and Lake Mackay in the Northern Territory). The animal was probably caught by one of Terry's Aboriginal assistants and eaten for dinner.

Aboriginal elders, consulted in the 1980s about their lost animals, remembered this one as plentiful and widespread, knowing it as 'kalanpa', 'tjuntatarrka' and by many other names. It lived on sandplains and dunes with spinifex, and could be caught at its daytime shelters in vegetation if approached with enough stealth. It was remembered from more than 40 locations in the deserts of the Northern Territory, Western Australia and northern South Australia. The last to see it were Pintupi people in the Gibson Desert of Western Australia, who recalled it at Kiwirrkurra and Warla Warla in 1960. Kiwirrkurra has been described as the most remote community in Australia.

EXTINCT

Primary Cause
INVASIVE SPECIES

1960s

The extinction of the central hare-wallaby is blamed mainly on foxes and cats. Larger fires, after Indigenous people left the deserts, probably contributed to its demise by removing food plants and also shelter that hid hare-wallabies from predators – especially foxes and cats.

Michael Terry was not a serious naturalist, but his remote travels enabled him to 'discover' a second species of mammal near Lake Mackay that no other white person ever saw – the desert bettong. Terry brought back its skull from another expedition the following year. A jaw of this species was subsequently found in a cave on Nullarbor Plain, 1,200 kilometres away, but no other remains have survived. Its extinction is also blamed on cats and foxes.

Formal national status	Extinct
Expert assessment of extinction causes	Fox 45%, cat 42% (Woinarski et al. 2019)

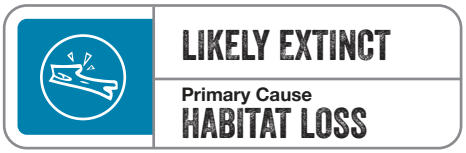
Main sources: Burbidge et al. 1988, Van Dyck and Strahan 2008, Woinarski et al., 2014

Victorian grassland earless dragon

(*Tympanocryptis pinguicolla*)

The once-vast basalt grasslands that extended from Melbourne to Geelong were the only home of this lizard. Most of its habitat has been replaced by farms, houses, factories and roads. The native grasslands that remain have been damaged in many ways – from livestock grazing, ploughing, changed fire regimes, weed invasion, feral predators, rock removal and use of agricultural chemicals.

The last confirmed sighting of this earless dragon was near Geelong in 1969. Sightings claimed in 1988 and 1990 are doubted today because follow-up searches were unsuccessful. Many other surveys of remnant grasslands have failed to detect the dragons, but there are sites that have not been thoroughly searched. This is a shy and difficult lizard to detect, so it might yet survive, but many experts are pessimistic.



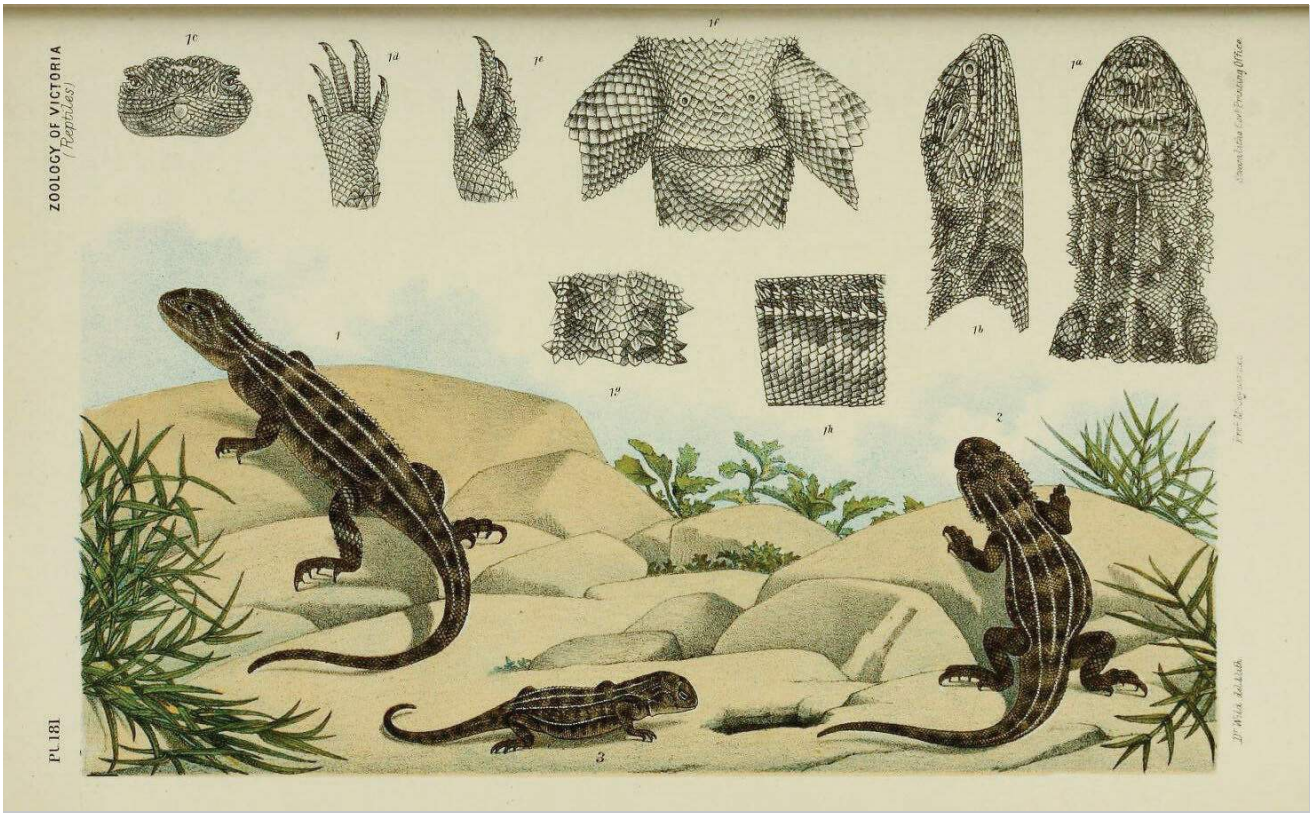
1960s

The Australian Government lists it as endangered, but in 2022 a group of experts rated it as most likely extinct with an 87% likelihood.

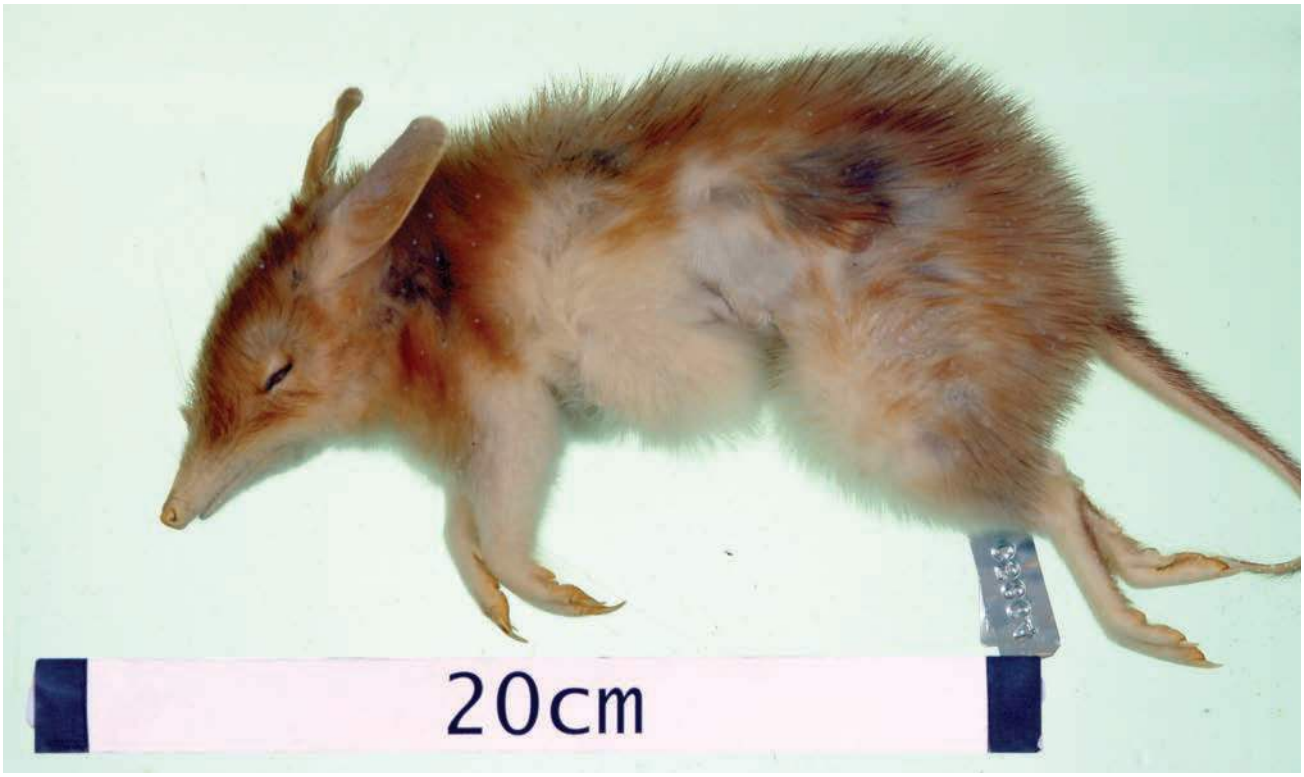
This species of lizard had previously been defined more broadly to include endangered earless dragon populations in southern New South Wales and the Australian Capital Territory. In 2019, herpetologists decided there were enough differences to recognise 4 species, all of which are doing badly, although this is the only one to have disappeared.

Formal national status	Endangered
Expert assessment of extinction likelihood	87% (Garnett et al. 2022)
Expert assessment of primary threat	Habitat loss and degradation (Chapple et al. 2019)

Main sources: Melville et al. 2019, Robertson and Evans 2009



Artwork: John James Wild (source: Museums Victoria)



This specimen collected in 1896 (the holotype) informed the scientific description of the desert bandicoot. Some had orange fur and others did not. Photo: David Staples (© Museums Victoria)

Desert bandicoot
(*Perameles eremiana*)

The desert bandicoot is one of 5 extinct mammals whose bones have been retrieved from 2 caverns at Uluru (Ayers Rock) where owls and dingoes once fed on them as prey.

The scientist who knew this mammal best was Hedley Finlayson, who, in 1961, after multiple desert expeditions, recalled that it had been fairly plentiful in the early 1930s in and around the Great Victoria Desert in South Australia, 'but is now absent or rare in this fox infested quarter'. He believed it still survived further north.

When Aboriginal elders in outback Australia were asked in the early 1980s about rare and missing mammals, many recalled this species as living across a vast area.

EXTINCT

Primary Cause
INVASIVE SPECIES

1970s

They said it disappeared from various regions 15 to 40 years prior. The most recent recollections came from Pintupi people who spoke of eating it 15–20 years before in an area near Lake Mackay in the Great Sandy Desert. That could mean the species survived until the 1970s. It lived on sandplains and dunes with spinifex, and on tussock grass flats, and sheltered in grass-lined nests in scrapes hidden under litter, grass or a shrub.

Foxes and cats are blamed for the desert bandicoot's extinction. The large fires that sometimes followed the end of Aboriginal burning may also have contributed to its plight by reducing food and shelter from predators.

Formal national status	Extinct
Expert assessment of extinction causes	Cat 50%, fox 40% (Woinarski et al. 2019)

Main sources: Burbidge et al. 1988, Finlayson 1961, Van Dyck and Strahan 2008, Woinarski et al. 2014

Southern day frog
(*Taudactylus diurnisa*)

The southern day frog was the first Australian frog lost to chytrid fungus (*Batrachochytrium dendrobatidis*), an Asian pathogen thought to have arrived in Brisbane in the 1970s. The day frog lived along streams in rainforest on Mt Nebo and Mt Glorious, less than an hour's drive from the city. It inhabited 3 small mountain ranges, and was last seen in the d'Aguilar Range (near Brisbane) in 1975, a little further north in the Blackall Range in 1978 and in the Conondale Range in 1979.

Frog experts were baffled by its disappearance. They wondered about pollutants, climate change, UV light, disease, and natural population fluctuations, none of which seemed to fit the evidence. When more frog species disappeared further north in Queensland and chytrid fungus was found on some that died, it was accepted as the explanation for 2 southern Queensland extinctions – that of this frog and the southern gastric brooding frog, which lived alongside some of the same streams.

EXTINCT

Primary Cause
INVASIVE SPECIES

1970s

A decade after this frog disappeared, biologists Greg Czechura and Glen Ingram wrote down everything they knew about it in an article that paints a rich picture of a lost species. Southern day frogs were, as their name suggests, active by day and often energetic, moving across leaf litter and swimming in water. They would bask in shafts of sunlight or perch for long periods on warm rocks. When startled they would leap into fast-flowing water to be swept away or dive down to hide among submerged stones and debris. Males made soft clucking calls from leaf litter along streams. At night they could be found in rock crevices, in burrows, under debris, in fallen palm fronds or clinging to vegetation. The females deposited their eggs in gelatinous clumps under rocks in the water. They were 'abundant'.

Formal national status	Extinct
Expert assessment of extinction causes	Chytrid fungus 98% (Woinarski et al. 2019)

Main sources: Czechura and Ingram 1990, Geyle et al. 2021

The southern day frog was the first species in Australia, and possibly the world, to go extinct from chytrid fungus.
Photo: © Dr Hal Cogger

This water-saturated white beach was the only habitat for the unusual Lake Pedder earthworm. Photo: provided by Janette Asche. Inset: Holotype specimen at the Tasmanian Museum

Lake Pedder earthworm

(*Hypolimnus pedderensis*)

EXTINCT

Primary Cause

ALTERED HYDROLOGY

1970s

The flooding in 1972 of Tasmania's remote Lake Pedder for unneeded hydroelectric power sparked national protests, pivotal to the rise of the green movement in Australia. Pedder was Australia's only glacial outwash lake, its main feature a wide quartzite beach that was 2.5 kilometres long. A year before inundation, a biologist who investigated the water-logged sand of the beach collected a single small (5-centimetre long, 1.6-millimetre thick) earthworm of a species not seen before or since.

That worm received the posthumous name *Perionychella pedderensis* in 1974. But earthworm expert Rob Blakemore decided it was so different, partly from adaptations to the unusual water-saturated sand (fewer pores, for example), that in 2000 he created a new genus to accommodate it: *Hypolimnus*, meaning 'beneath the lake'.

Searches for this species in the region around the dam proved fruitless, leading to the conclusion that it had evolved to live within that particular beach, and that it lives no more. According to Earthworm Watch, it is the world's only extinct earthworm. It is also the only invertebrate listed by the Australian Government as extinct, despite others being listed as such by state or territory governments.

The Lake Pedder galaxias, a small fish that also suffered when Lake Pedder was dammed, escaped complete extinction because some were captured just in time and established in another (smaller) lake and a small dam (page 28). The Lake Pedder planarian (*Romankenkius pedderensis*), a carnivorous flatworm, was initially recorded as extinct (and is still listed as such by the IUCN), but was found some 3 decades later living in the dam in its original locale.

Formal national status	Extinct
Expert assessment of extinction causes	Dam 100% (Woinarski et al. 2019)

Main sources: Blakemore 2000, Department of the Environment 2009, Forteath and Osborn 2012

Kuchling's turtle

(*Chelodina kuchlingi*)

This obscure turtle is only known from 4 specimens, 3 collected in 1965 by renowned naturalist Harry Butler, and one in 1974, all from Parry Creek in the eastern Kimberley of Western Australia. The Parry Lagoons Nature Reserve was created in 1971, protecting part of their habitat, but the turtle has gone missing nonetheless. Searches in the 21st century have failed to find it, instead recording the Kimberley long-necked turtle (*C. walloyarrina*) and northern snake-necked turtle (*C. rugosa*).

Parry Creek is on the floodplain of the Ord River, the hydrology of which has been changed by the damming of the river upstream and the development of large farms connected by canals.

These canals established 'open channel connectivity'

?

LIKELY EXTINCT

Primary Cause
UNCERTAIN

1970s

close to the Victoria River catchment in the Northern Territory, and may have provided the means for the northern snake-necked turtle to travel to Parry Creek, where it had not previously been seen. Since arriving, it appears to have displaced Kuchling's turtle, perhaps in part by breeding with it. The 2 species are similar and closely related.

The widespread northern snake-necked turtle may qualify as an invasive species if it did indeed disperse through the canal system.

A group of experts in 2022 gave Kuchling's turtle a 70% chance of being extinct. It would be Australia's first turtle extinction.

Formal national status	Not listed
Expert assessment of extinction likelihood	70% (Garnett et al. 2022)

Main source: Kuchling 2020

This is the northern snake-necked turtle (*C. rugosa*), which closely resembles Kuchling's turtle and seems to have displaced it. Above is Parry Lagoons Nature Reserve, protecting part of Parry Creek, the only known habitat of Kuchling's turtle. Photos: © Anders Zimney (turtle), Caroline Jones (lagoon)

"I am one of the fortunate few to have seen gastric-brooding frogs but I don't feel lucky. Just horrified that they were lost in my lifetime."
Steve Wilson

The southern gastric brooding frog is the world's prime example of extinction depriving humanity of a medical resource, although it was far more than that. Photo: © Steve Wilson. Inset: Michelle McFarlane (© Museums Victoria)

Southern gastric brooding frog
(*Rheobatrachus silus*)

In the mountains of southern Queensland in 1971, biologist David Liem discovered a frog like none ever seen before. It didn't merely live near water, but was truly aquatic, staying below for hours on end. It reared its young in an amazing way: the mother swallowed her fertilised eggs, and the tadpoles lived in her stomach, to emerge as tiny frogs from her mouth.

The southern gastric brooding frog became world famous and was subject to detailed research, but that had to end when the frog disappeared from streams in the Blackall and Conondale Ranges in the 1970s. Before its disappearance, biologist Glen Ingram studied a wild population at his field site. In 1976 he recorded 59 frogs, 35 the next year, 24 the next, then 2, then zero in 1980. A gastric brooding frog seen by someone else in 1981 became the last one ever seen in the wild.

The extinction is blamed on chytrid fungus (*Batrachochytrium dendrobatidis*), a pathogen that somehow reached Australia from Asia and caused multiple frog extinctions.

In a submission to the recent senate inquiry into Australia's extinction crisis, Doctors for the Environment highlighted the loss of this species as a missed opportunity to understand its potential medical benefits. The frogs transformed stomach muscle into a version of uterine muscle, using mediators that might have cured muscle diseases in humans, had they been identified.

EXTINCT
Primary Cause
INVASIVE SPECIES

1980s

The book *Sustaining Life: How Human Health Depends upon Biodiversity* (2010), which was sponsored by the United Nations and IUCN, also highlighted the loss of this frog and the foregone medical insights.

In 2005, an ambitious team of scientists attempted to undo extinction and revive this species. Project Lazarus entailed taking cell nuclei from a dead gastric-brooding frog stored in a freezer by a biologist in the 1970s. These were inserted into the de-nucleated eggs of a related frog. After hundreds of trials the first signs of progress came in 2013 – a donor cell divided into a ball of cells. But although DNA from the extinct frog would build and replicate cells, it would not keep this going in any of the native frogs tested. DNA from the donor frog was interfering. Even so, the world was impressed, and the team won an award from *Time* magazine. Project Lazarus is on ice for now. Had it succeeded, the thylacine would have been up next.

Formal national status	Extinct
Expert assessment of extinction causes	Chytrid fungus 98% (Woinarski et al., 2019)

Main sources: Chivian and Bernstein 2008, Czechura and Ingram 1990, Geyle et al. 2021, Groves 2021, University of Newcastle 2013

Northern gastric brooding frog

(*Rheobatrachus vitellinus*)

EXTINCT

Primary Cause

INVASIVE SPECIES

1980s

The northern gastric brooding frog was found and lost in a little over a year. It was discovered in January 1984, and by June the following year it had vanished, never to be seen again.

Its demise was well documented because the Queensland National Parks and Wildlife Service began a monitoring program in the very month of its discovery. For 2–5 days every month, biologist Keith McDonald visited Eungella National Park, where it lived along rainforest streams. He searched small streams at night with a headlamp, and looked by day under fringing vegetation and rocks, finding 'abundant' frogs at each site, sometimes as many as 6 along a 5-metre stretch of creek.

Signs of decline came in January 1985, although the frogs remained plentiful at higher altitudes until March. Then for 2 months McDonald did not visit, and when he returned in June he could not find a single northern gastric brooding frog. Many subsequent searches also failed.

Populations of another frog in the same streams, the Eungella torrent frog (*Taudactylus eungellensis*), also crashed at the same time, but this frog did not go extinct.

A serious last-ditch search for the northern gastric brooding frog came in 2021, when scientists were dropped by helicopter into the remote western side of the Eungella Range, to camp for 3 nights and search creeks that had not been visited before. They found ideal habitat but no gastric brooding frogs. Water samples tested for residual DNA from frogs living upstream did not yield any positives.

McDonald was mystified at the time by the disappearances. These rainforests had not been disturbed by logging, clearing or mining. The weather had not been unusual.

In 1996 he became one of 3 biologists to publish a controversial paper proposing that a mystery epidemic had caused this and other frog disappearances and declines. Two years later a paper announced the discovery of amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), detected in large numbers on dead and dying frogs in north Queensland rainforests and also in Panama. The consensus today is that the northern gastric brooding frog, along with the southern gastric brooding frog and the more fortunate Eungella torrent frog, were victims of this fungus, which originated in East Asia.

Formal national status	Extinct
Expert assessment of extinction likelihood	Chytrid fungus 99% (Woinarski et al. 2019)

Main sources: Geyle et al. 2021, McDonald 1990

When the northern gastric brooding frog went extinct the world ceased to have any animals that rear young in their stomachs.
Photo: © Dr Hal Cogger

The gravel downs ctenotus may have been doomed by native rodents reaching plague numbers allowing cats to multiply.
Photo: © David Knowles

Gravel-downs ctenotus

(*Ctenotus serotinus*)

The gravel-downs ctenotus appeared to be a common lizard when it was last seen in south-western Queensland in 1984, but many searches since then have failed to find it. It was found on 2 pastoral properties in the Diamantina Lakes region, the first in 1981 in sandy country with spinifex, canegrass and Georgina gidgee trees, and 3 years later at a location about 40 kilometres away in a narrow zone between sandy dunes and adjacent stony soils.

One biologist who helped discover the species deemed it slower-moving than many ctenotus skinks, suggesting high vulnerability to cats, which feed heavily on small desert lizards and reach very high densities after plagues of native desert rats. In 1992 army sharpshooters shot 500 cats around a bilby colony on Davenport Downs Station, the property on which the lizard was last seen.

LIKELY EXTINCT

Primary Cause
INVASIVE SPECIES

1980s

The other site has become part of Diamantina National Park, where 8 searches between 1999 and 2017 failed to find it, including in locations both near the original sites and in a wider region.

The Threatened Species Scientific Committee determined that predation by cats, combined with habitat degradation from grazing and weed invasion, are the most plausible threats to the species, if it still survives. Grazing and fires could have increased the vulnerability of the lizards to cat predation. Experts have assessed it as most likely extinct (72% likelihood).

Formal national status	Critically endangered
Expert assessment of extinction likelihood	72% (Garnett et al. 2022)
Expert assessment of primary threat	Cat (Threatened Species Scientific Committee, 2021)

Main sources: Chapple et al. 2019, Czechura 1986, Threatened Species Scientific Committee 2021

Unlike other extinct species on the island, the Christmas Island shrew lingered for many decades before it appears to have vanished. Illustration: © Owen Bell

Christmas Island shrew

(*Crocidura trichura*)

Most Australians don't know about Australia's native shrew – a tiny mammal that once skittered about in the rainforest on Christmas Island. The first naturalist to see it was Joseph Jackson Lister in 1887. 'This small Shrew-Mouse was very abundant in the woods,' he wrote, 'and their short shrill squeak was often heard all round as one stood quiet among the trees'. A decade later another visiting naturalist, Charles Andrews, offered a very similar comment: 'this little animal is extremely common all over the island, and at night its shrill squeak, like the cry of a bat, can be heard on all sides.' He said it fed mainly on small beetles.

When Andrews returned a decade later the island had changed dramatically. Black rats (*Rattus rattus*) brought to the island in a shipload of hay in 1899 brought parasitic protozoans – trypanosomes (*Trypanosoma lewisi*) – in their blood, which caused the swift extinction of the island's 2 native rodents, Maclear's rat (*R. macleari*) and the bulldog rat (*R. nativatus*).

The shrew seemed to be extinct as well. None were seen until 1958, when 2 were discovered during a mining operation to clear some rainforest. Two more turned up in the 1980s. A female was caught by hand on a rainforest walking trail in December 1984 and kept in the hope a mate for it could be found. A male was found 3 months later inside a bird's-nest fern that fell from the canopy, but it was feeble and soon died. The female lasted a year in captivity, and no shrews have been seen since.

LIKELY EXTINCT

Primary Cause

INVASIVE SPECIES

1980s

In the late 1990s Paul Meek and colleagues at Parks Australia worked earnestly to find some. Over 17 months Meek ran a vast survey, laying cage traps and hair tubes (to collect hair), digging pitfall traps, and recording nocturnal sounds. No trace of any shrew was found.

A national recovery plan for the shrew published in 2004 called for the establishment of a captive breeding colony, but the time for that seems to have passed. In 2018 the Australian Government listed the species as critically endangered, but many experts believe it has been extinct for some time.

This shrew lost some habitat to land clearing for phosphate mining, but that can't account for its loss: two-thirds of the island rainforest remains, most of which is protected inside a national park, and the shrew went from extremely common inside rainforest to very rare within a decade. It was evidently hit by trypanosome infection, and since then has faced other introduced species: feral cats, black rats, and yellow crazy ants (*Anoplolepis gracilipes*) forming supercolonies. The fipronil poison used to control crazy ants kills other insects as well and may have reduced its food supply.

Formal national status	Critically endangered
Expert assessment of extinction likelihood	92% (Garnett et al. 2022)
Expert assessment of primary threat	Trypanosome parasite (high), cat (medium), black rat (medium) (Ward et al. 2021)

Main sources: Meek 1997, Meek 2000, Schulz 2004, Threatened Species Scientific Committee 2017a

Lyon's grassland striped skink
(*Austroablepharus barrylyoni*)

This small lizard is only known from grassland on Springfield Station in north Queensland. The 4-square-kilometre site is a flood-prone basalt plain on which cattle are fattened.

As well as heavy grazing and trampling by cows, the grassland is invaded by smothering weeds, mainly rubber vine (*Cryptostegia grandiflora*), Indian couch (*Bothriochloa pertusa*) and grader grass (*Themeda quadrivalvis*). The skinks were surviving there in the 1970s and 1980s, but many searches since then in the paddock and surrounding areas have failed to find any.

LIKELY EXTINCT

Primary Cause
HABITAT DEGRADATION

1980s

The IUCN lists this lizard as critically endangered, but a group of experts in 2022 gave it a 77% chance of being extinct already. In a 2019 assessment, 'soil compaction and weed encroachment' were named as the likely threats to its survival. Both cattle grazing and weed invasion have intensified at the site since the skinks were last seen.

Formal national status	Not listed
Expert assessment of extinction likelihood	77% (Garnett et al. 2022)
Expert assessment of primary threat	Grazing, weed invasion (Chapple et al. 2019)

Main sources: Chapple et al. 2019, Couper et al. 2018

Lyon's grassland striped skink has never been photographed alive. Photo: © Steve Wilson

Mountain mist frog
(*Litoria nyakalensis*)

This frog of north Queensland's wet forests was declared extinct by the IUCN in 2022, following many searches by dedicated herpetologists since 1990 that failed to produce a single sighting. The Queensland and Australian governments call it 'critically endangered' in the hope survivors will yet be found. In 2020 a group of experts conceded it was highly likely to be extinct. Its disappearance is blamed on chytrid fungus (*Batrachochytrium dendrobatidis*), an Asian pathogen that swept north through Queensland in the 1980s from an apparent arrival point in Brisbane.

Mountain mist frogs had perched on vegetation and rocks along fast-flowing streams in upland rainforest. Their tadpoles were adapted for rapids and runs, adhering to rocks by their mouths, which had 5 rows of gripping teeth. They fed by rasping algae from rocks and had very muscular tails for swimming upstream.

The mountain mist frog has a very close relative, the common mist frog (*L. rheocola*), that was lucky to escape the same fate. In 2000 it was listed as endangered after populations living above 400 metres altitude succumbed to chytrid fungus. But this frog has lowland populations that survived because chytrid fungus cannot tolerate temperatures above 28°C. Common mist frogs have recolonised some upland sites, probably by adapting to survive the fungus. The species was delisted in 2020.

Formal national status	Critically endangered
Expert assessment of extinction likelihood	93% (Geyle et al. 2021), 85% (Garnett et al. 2022)
Expert assessment of primary threat	Chytrid fungus (Gillespie et al. 2020)

Main sources: Geyle et al. 2021, McKnight et al. 2017, Threatened Species Scientific Committee 2017c

This species was declared extinct by the IUCN in 2022 but remains listed as critically endangered by the Australian Government on the chance it still survives in remote parts of the Wet Tropics. Its call has been described as a soft, slow, popping growl. Photo: © Martin Cohen

When Martin Cohen took this photo, sharp-snouted day frogs were so plentiful he had to pause before each step until they hopped out of the way. Photo: © Martin Cohen

Sharp-snouted day frog

(*Taudactylus acutirostris*)

In the rainforests of north Queensland this frog, though small, attracted attention to itself by being active by day, widespread and noisy. Males often called all day from first light into the evening, like a spoon tapping on a glass: 'tink...tink...tink'. They were so common that as many as 20 might be found along 20 metres of stream.

In the 1980s they began disappearing from the southern parts of their range in the Wet Tropics, in an extinction wave that rolled north for 300 kilometres until it hit the Big Tableland at the very top of the Wet Tropics. Here, out of concern about many disappearances, national park ranger Keith McDonald began in 1992 to monitor the frogs every 4 to 6 weeks. In late 1993 the wave struck, bringing down 3 species he was watching. Along a hundred metre stretch of stream he saw numbers of day frogs plummet from a high of almost 80 to zero in a couple of months.

EXTINCT

Primary Cause

INVASIVE SPECIES

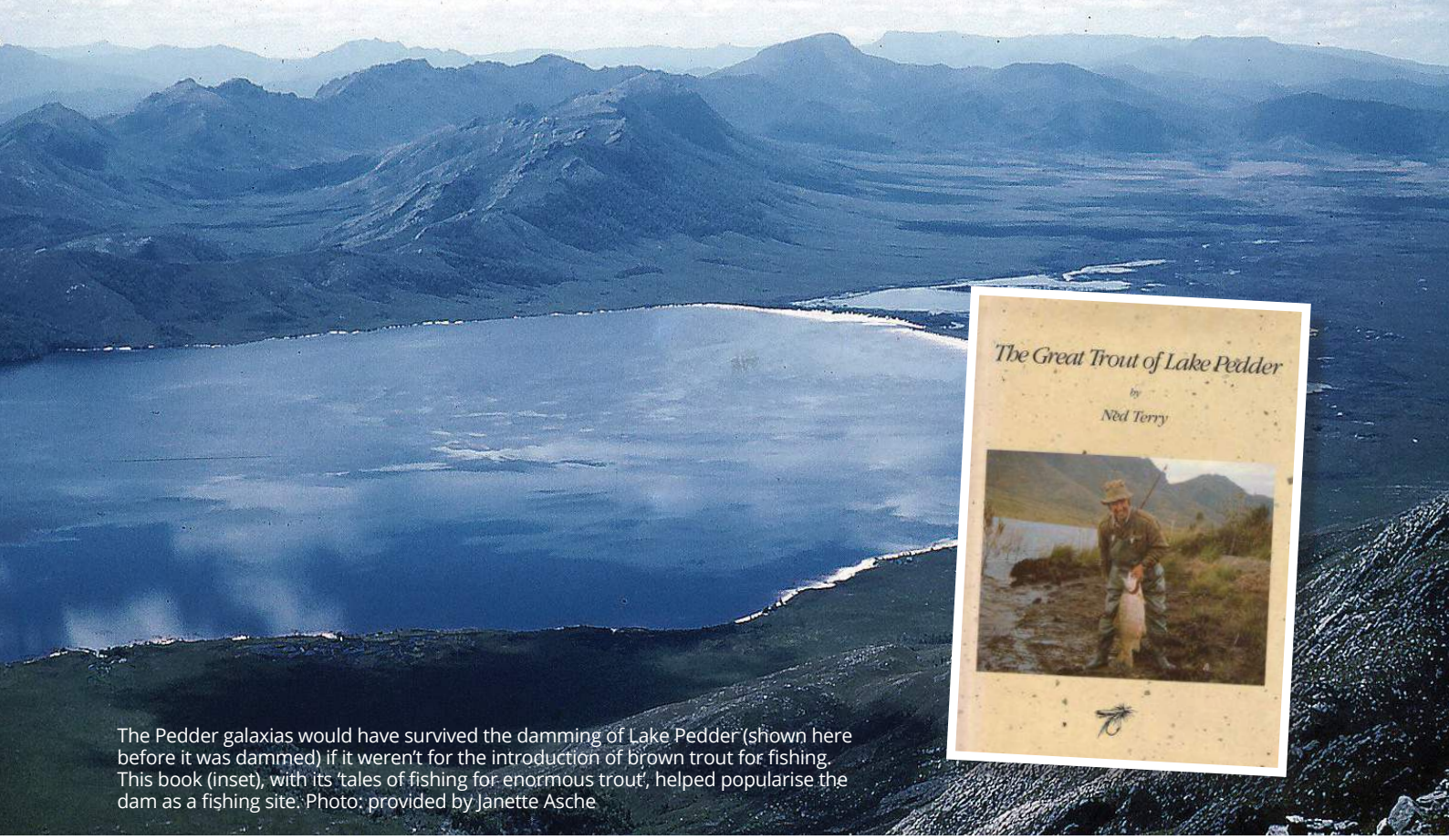
1990s

In a frantic bid to save the species more than a hundred sharp-snouted day frogs and tadpoles were collected for captive breeding at Taronga Zoo and Melbourne Zoo. Despite the best possible care, they succumbed to infections and died – every single one. A colony kept for breeding at James Cook University in Townsville also died out. The species was unsavable. The last wild sighting was in 1997.

This extinction is one of several blamed on chytrid fungus (*Batrachochytrium dendrobatidis*), a pathogen from Asia. The fungus was found on dead and dying frogs collected at Big Tableland and on frogs that died at Melbourne Zoo.

Formal national status	Extinct
Expert assessment of extinction causes	Chytrid fungus 99% (Woinarski et al. 2019)

Main sources: Geyle et al. 2021, Schloegel et al. 2006



The Pedder galaxias would have survived the damming of Lake Pedder (shown here before it was dammed) if it weren't for the introduction of brown trout for fishing. This book (inset), with its 'tales of fishing for enormous trout', helped popularise the dam as a fishing site. Photo: provided by Janette Asche

Pedder galaxias
(*Galaxias pedderensis*)

In the 1970s Lake Pedder in Tasmania was flooded to create a large hydro-electric dam, which became a world-renowned trout fishery. Nutrients from the drowned peat soils and vegetation fuelled a dramatic multiplication of small invertebrates, which fed small native fish that became food for brown trout (*Salmo trutta*). The trout grew plump and plentiful on the bounty.

The main native fish in the lake, the Pedder galaxias, thrived at first, until the trout population surged. Fishermen drawn to the lake used the galaxias as live bait, catching many trophy-sized trout weighing up to 8 kilograms. So imposing were these trout that one fisher wrote a book about them, *The Great Trout of Lake Pedder*. Trout entered the dam after it inundated the headwaters of the Huon River, into which they had been stocked as a sport fish. The Inland Fisheries Commission 'helped' in 1972 by adding 350,000 hatchery-raised brown trout fry.

When inundation took Lake Pedder from its original 9 square kilometres to a massive 235 square kilometres, the galaxias population surged at first, to peak in 1977 with large schools of young swarming in the shallows. But 4 years later those schools had vanished, gulped down by trout. Intensive surveys in 1988 and 1989 located no galaxias at all in the dam. Just 11 fish could be found across 4 small streams that fed into the lake.

EXTINCT IN THE WILD

Primary Cause
INVASIVE SPECIES

1990s

With the Pedder galaxias close to extinction, the Inland Fisheries Commission tried to keep and breed some but, for want of expert care, they did not breed or survive long. The next plan was to place some in another lake. Lake Oberon, 25 kilometres to the south and deep inside Southwest National Park, was less than 2% the size of the original Lake Pedder, but free of trout and other fish. All the Lake Pedder galaxias that could be found were released there – 31 in 1991–92 and 3 more in 1997, taken from feeder streams in Lake Pedder shortly before they disappeared. The galaxias took to their new home and a population of several thousand is estimated today.

From 2001 to 2007, 353 galaxias were moved from Lake Oberon to Strathgordon Dam – a water supply dam for the township of Strathgordon, just north of Lake Pedder – to create an 'insurance' population. The galaxias freed here did not start breeding until rocks were placed in the water as spawning sites.

The Pedder galaxias is listed as extinct in the wild, because the new populations are outside the original range of the species. Trout are, for very good reasons, blamed for the extinction. They are smaller today for want of their erstwhile food. Climbing galaxias (*Galaxias brevipinnis*) also entered Lake Pedder after the dam was created, and these large galaxias may have contributed to the demise of their smaller relative.

Formal national status	Extinct in the wild
Expert assessment of extinction causes	Brown trout 77%, dam 20% (Woinarski et al. 2019)

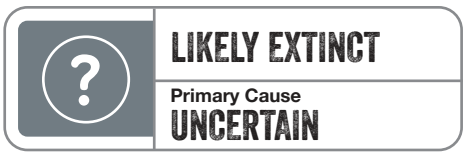
Main sources: Chilcott et al. 2013, Sanger 2001

Kangaroo River Macquarie perch
(*Macquaria* sp.)

This undescribed species was once plentiful in the Kangaroo River, a largely undisturbed tributary of the Shoalhaven River in coastal New South Wales. That was until introduced carp (*Cyprinus carpio*) were illegally freed in the river in the 1990s and there was stocking of hatchery-bred Australian bass (*Macquaria novemaculeata*), which are native to the river. In that same decade the perch declined very rapidly to extinction, and by 1998 none could be found despite many searches. One individual survived in captivity until 2008.

A genetic study provided the basis for distinguishing the Kangaroo River Macquarie perch as a species by indicating a substantial genetic divergence from other Macquarie perch populations, implying separate evolution for about 2 million years.

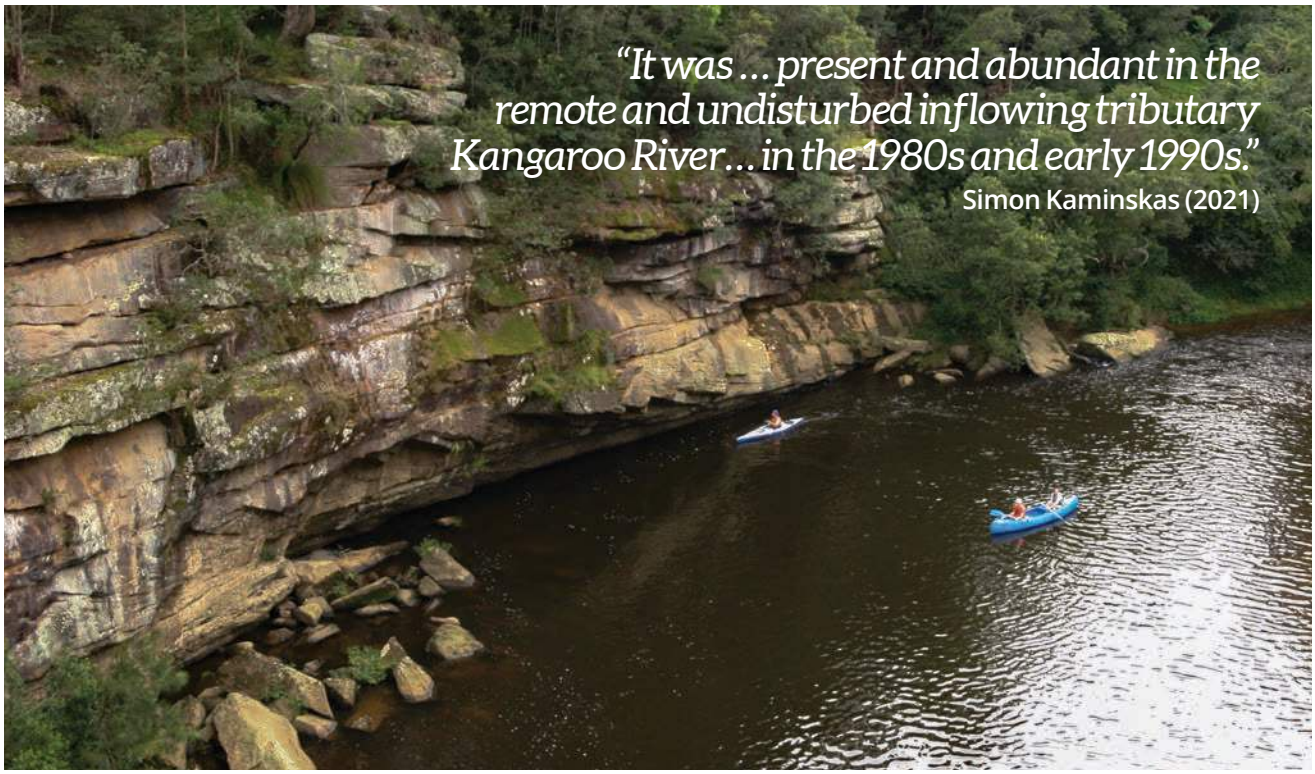
Fish expert Simon Kaminskas of the Murray-Darling Basin Authority proposed that the 'rapid and so far unexplained collapse' strongly suggests a pathogen was introduced into the catchment with one of the introduced fish species. He nominated epizootic haematopoietic necrosis virus (EHNV), or some other introduced viris of the Iridoviridae family, as a likely culprit. EHNV is known elsewhere to have caused declines of Macquarie perch (*Macquaria australasica*), silver perch (*Bidyanus bidyanus*) and galaxias species (*Galaxias* spp.). Proving that a virus caused the sudden disappearance is not possible, but no other explanation has been suggested.



The Kangaroo River Macquarie perch is Australia's first completely extinct fish species, and it's unlikely it will be the last. Fish experts have nominated 22 species of small stream fish at imminent risk of extinction, mainly from trout and other translocated fish species.

Formal national status	Not listed
Expert assessment of extinction likelihood	89% (Garnett et al. 2022)
Expert assessment of primary threat	Unknown, but speculation of an exotic disease (Kaminskas 2021)

Main sources: Faulks et al. 2010, Kaminskas 2021, Lintermans et al. 2020



Extinctions were not expected in the Kangaroo River, one of the least disturbed rivers of south-eastern Australia. Photo: Martin Kraft

It could be located by its calls … made by choruses of males concealed beneath rocks, roots and debris

Photo: © Martin Cohen

Northern tinker frog

(*Taudactylus rheophilus*)

Fears about mass extinctions from climate change came to a head in a famous paper in *Nature* in 2004, with this species included as one of many expected to succumb to a one degree rise in temperature. This frog had, however, probably already vanished by the time the paper appeared – taken out by chytrid fungus (*Batrachochytrium dendrobatidis*), a deadly introduced disease.

Climate change threatened this frog because it lived only in cloud forest above 940 metres altitude on 4 mountain ranges in the Wet Tropics. By day it sheltered alongside fast-flowing streams and nearby soaks. It could be located by its calls – 'tink...tink...tink' – made by choruses of males concealed beneath rocks, roots and debris. In 1991 it went missing, and there were grave fears it had become one of Queensland's infamous missing frogs. In 1996 relief came when it was rediscovered on Mt Lewis and Mt Bellenden Ker. But it did not linger – it was last seen on Mt Lewis in January 1999 and on Bellenden Ker in December 2000, when national park rangers in a search lasting 5 days found a group of 3 to 5 calling males among granite boulders and northern stream lilies in an area of less than 9 square metres. The next time that site was visited they were gone. Four years previously the frogs had occupied 150 metres of that stream.

LIKELY EXTINCT

Primary Cause

INVASIVE SPECIES

2000s

Many subsequent searches, including 10 trips in the summer of 2003, failed to locate the northern tinker frog in any of the 4 ranges it once inhabited. Sound recorders stationed on Mt Lewis and Bellenden Ker failed to detect it. The Australian Government lists it as critically endangered, with frog experts in 2021 noting 'a small possibility of persistence of remnant populations' in some especially remote location. But there are strong reasons to fear the species has been extinct for some time – one of 6 or more species eliminated by chytrid fungus.

Formal national status	Critically endangered
Expert assessment of extinction likelihood	90% (Geyle et al. 2021), 86% (Garnett et al. 2022)
Expert assessment of primary threat	Chytrid fungus (Gillespie et al. 2020)

Main sources: Geyle et al. 2021, Threatened Species Scientific Committee 2017b

White-chested white-eye

(*Zosterops albogularis*)

This is Australia's most recently extinct bird, and the only bird species lost from Australia since 1927. A denizen of Norfolk Island, it was common when surveyed in 1926, but by 1962 fewer than 50 were thought to survive. Rigorous searches by visiting ornithologists in the 1980s, 2009, and more recently have failed to find it, and in 2000 it was declared extinct. A final plausible sighting was made by resident naturalist Margaret Christian in 2005. On two occasions that year she said she saw a single bird.

Black rats, which arrived on the island in about 1943, are blamed for its demise. Further east, on Lord Howe Island, black rats caused several bird extinctions, including that of the robust white-eye, a closely related bird.

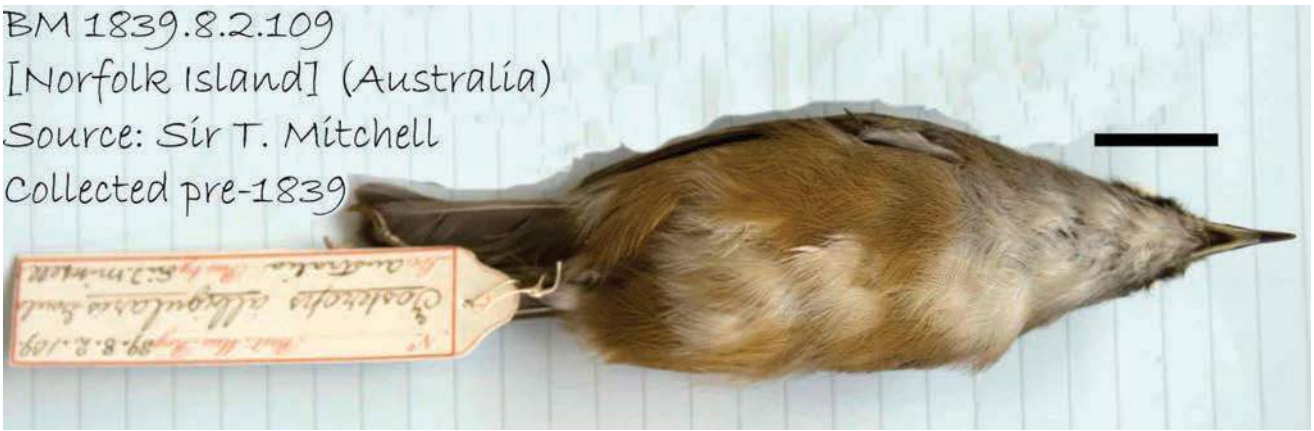
The white-chested white-eye was not helped by past clearing of its habitat. Only 10% of the subtropical rainforest on the island remains, mainly in the national park. The white-eyes were known to visit weedy vegetation and gardens, but the large areas of pasture were unusable. With most of the clearing having taken place during the convict era in the 19th century, this doesn't explain the decline in the 20th century.

The arrival of the silvereye from Australia – a closely related bird with a similar diet – would not have helped the white-chested white-eye. The island also has slender-billed white-eyes living in the rainforests and all 3 species would have operated as competitors. In 2013 silvereyes and slender-bills were estimated to each have a population of 4,000 or more. They are slightly smaller birds than their extinct cousin.

White-chested white-eyes could have been saved without much effort if some had been caught in the 1960s for a captive colony. Asian species of white-eye are easy to keep in cages and often sold in bird markets.

Formal national status	Extinct
Expert assessment of extinction causes	Black rat 68%, land clearing 23% (Woinarski et al. 2019)

Main sources: Dutson 2013, Garnett & Baker 2020



John Gould, who named the white-chested white-eye, warned that Australians 'should at once bestir themselves to render protection' to native birds: 'otherwise very many of them ... will soon become extinct.' Painting: Elizabeth Gould. Specimen photo: Richard Holdaway

The Christmas Island pipistrelle could have been saved by captive breeding, which had been recommended 3 years prior to its extinction. Photo: © Lindy Lumsden

Christmas Island pipistrelle

(*Pipistrellus murrayi*)

These tiny bats were so plentiful on Christmas Island during the early 1900s they 'used to fly in through the open doors, and now and then you could see one fall off the light, or off somewhere onto the table, or into someone's soup', resident Gladys Randell recalled.

Until the mid-1980s they remained common, then surveys in 1994 and 1998 recorded sharp declines. By 2005, there were 80% fewer than in 1994.

Biologist Lindy Lumsden and 3 colleagues from the Arthur Rylah Institute for Environmental Research were commissioned to investigate the decline. After ruling out disease, they concluded in their 2007 report that the only other possible threats were various introduced species, all of which appeared to be increasing – Asian wolf snakes (*Lycodon capucinus*), giant centipedes (*Scolopendra subspinipes*), giant African snails, feral cats, black rats and nankeen kestrels. Lumsden's team could not decide which among these had caused the decline, but noted that wolf snakes, arriving in the 1980s, were the only ones to reach the island just before the bat tanked and whose advance mirrored the bat's decline.

Doubts about the snakes – did they climb high enough up trees to reach bats roosting under bark or in hollows? did they use dense rainforest or keep to road edges and other disturbed locations? – were answered when an infra-red camera trained on the trunk of a pipistrelle roost tree photographed a climbing wolf snake inside rainforest far from any road.

In 2006, when the government's Threatened Species Scientific Committee assessed the bat as critically endangered, they suggested captive breeding was needed.

The Lumsden team also recommended captive breeding the following year. In January 2009, by which time as few as 20 bats remained, the Australasian Bat Society urged immediate action on captive breeding. On 1 July the minister agreed the last bats could be captured, but by the time bat biologists reached the island in August 2009 only one bat could be detected, flying regularly along certain tracks. It could not be caught and the last time it was heard calling, on 26 August, provides an exact date of species extinction. Bat detectors stationed on the island after that time failed to detect any. The Environment Minister copped criticism in the media for the department's slow response.

Biologist John Woinarski wrote a heartfelt book, *A Bat's End* (2018), about the demise of this species, saying the evidence fitted wolf snakes causing the extinction. He offered a second more complex possibility involving some habitat loss from mining, a cyclone in 1988 that destroyed many roost trees and possibly some bats, yellow crazy ants (*Anoplolepis gracilipes*) preventing access to some roost trees, and giant centipedes (*Scolopendra subspinipes*) and black rats (*Rattus rattus*) operating as predators. In 2017 he led an assessment of extinct mammals that blamed the pipistrelle's extinction mainly on wolf snakes, centipedes and crazy ants, with a minor contribution from the cyclone (10%) and clearing (5%).

Formal national status	Extinct
Expert assessment of extinction causes	Wolf snake 55%, giant centipede and yellow crazy ant 30% (Woinarski et al. 2019)

Main sources: Lumsden et al. 2007, Martin et al. 2012, Woinarski 2018

Bramble Cay melomys
(*Melomys rubicola*)

EXTINCT
Primary Cause
CLIMATE CHANGE

2000s

This rodent has attracted global attention as the first mammal whose extinction is blamed on climate change. It was confined to a tiny coral cay in Torres Strait with a maximum elevation of 3 metres, leaving it very vulnerable to extreme tides and storm surges associated with rising sea levels. Bramble Cay is smaller in area than the Melbourne Cricket Ground (if the grandstands are included). It varies greatly in size with weather conditions – from 4.5 hectares in December 2011, it dropped to 2.5 hectares in March 2014, before expanding to 3.4 hectares 6 months later from the addition of sand.

Until the 1980s the melomys was 'relatively abundant' on the cay, numbering several hundred. Low plants up to 40 centimetres high are the cay's only vegetation, and the melomys was known to feed on one of these, pigweed (*Portulaca oleracea*). Salty waves washing over the cay in 1990 killed most of the plants, and rodents were far fewer after that. Plant cover has declined further this century, from 2.16 hectares in 2004 to 0.065 hectares in March 2014 before expanding slightly to 0.19 hectares 6 months later.

The rodent's extinction is blamed on extreme tides and storm surges killing pigweed and possibly sweeping rodents out to sea. The melomys was last seen in 2009 by a visiting fisherman who found some sheltering under a dugout canoe that had evidently floated from New Guinea. Intensive surveys on the cay in 2011 and 2014 failed to find any. Nearby cays were also searched.

Coral reef evidence from other islands in Torres Strait (Yam and Hammond islands) indicates sea levels at least 0.8–1 metre higher than today during an early Holocene warming period 5,300 years ago, and seas remained higher for more than 3,000 years. Sand deposits back then may have raised Bramble Cay to greater heights than it has today, but that is less likely than the cay having had too little sand for any vegetation or rodents.

The instability of Bramble Cay has encouraged suggestions by experts that it was colonised relatively recently by melomys from New Guinea floating on debris. The cay is 53 kilometres from the mouth of the Fly River, and debris often arrives when the river is in flood. This has included a small hut attached to dislodged ground and a floating island 6 metres wide sporting a palm tree. A 2016 report quoted turtle researcher David Carter, who lived on the cay for 6 months during the 1979–80 wet season:

> *One of my strongest recollections is dawn light revealing a sea dotted with flood debris right to the horizon in every direction: trees, great rafts of nipa palms and tangles of grass and reeds from the Fly River we presumed. Some of these washed up on the Cay or stranded in the reef lagoon. As with every new feature, there were always rats climbing around on these beach washed items even as they tossed in the surf.*

This provides reason to suspect this melomys species survives today in the nearby Fly River region of New Guinea, which, researchers say, has not been thoroughly investigated for mammals. Bramble Cay melomys were renowned for their eagerness to climb up huts and any other structures erected on the cay, suggesting a recent past lived among trees, and a habit that would facilitate travel on flood-dislodged trees.

Formal national status	Extinct
Expert assessment of extinction causes	Sea-level rise 75%, other ecosystem modification 25% (Woinarski et al. 2019)

Main sources: Gynther et al. 2016, Waller et al. 2017, Woodroffe et al. 2000

Photo: State of Queensland

In just 35 years the forest skink went from being the most common reptile on Christmas Island to the first Australian reptile to be declared extinct.

Photo: © Dr Hal Cogger

Christmas Island forest skink

(*Emoia nativitatis*)

In just 35 years the forest skink went from being the most common reptile on Christmas Island to the first Australian reptile to be declared extinct. A drop in its numbers was noted during a reptile survey in 1998, although at that time it was possible to see as many as 80 around one fallen tree.

A decisive event was the arrival on the island in about 1982 of the Asian wolf snake (*Lycodon capucinus*), a predator that slowly radiated across the island from the settlement. By 2007 the range of the forest skink had shrunk to small colonies at the 3 ends of the island furthest from the township and port.

Park rangers tried to catch some for a breeding colony but the last lizards were wary, diving into crevices in jagged limestone when approached. Only 4 were caught before the species disappeared in the wild in August 2010, but one escaped after capture and 2 died in captivity from a mishap, leaving one survivor, known affectionately as Gump. Repeated attempts to source her a mate by scouring remote parts of the island rainforest failed, and on 31 May 2014 she died.

The extinction of the Christmas Island pipistrelle in 2009 attracted media publicity but mammals are more newsworthy than lizards, and Gump's passing barely registered. She was outlived by a shiny sign beside a popular national park trail telling visitors to look around at the forest skinks active nearby.

Some forest skinks were found decades ago in the stomachs of feral cats, and they probably also suffered from yellow crazy ants (*Anoplolepis gracilipes*). But the Asian wolf snake is most strongly implicated in their demise, and in that of 2 other lizards that vanished from the wild around the same time (although they survive in captivity). The snakes probably nabbed them when they were sleeping at night.

Formal national status	Extinct
Expert assessment of extinction causes	Wolf snake 82%, yellow crazy ant 12% (Woinarski et al. 2019)

Main sources: Emery et al. 2021, Smith et al. 2012, Threatened Species Scientific Committee 2020, Tiernan 2018

Blue-tailed skink

(*Cryptoblepharus egeriae*)

The township on Christmas Island once had blue-tailed skinks scampering over verandahs and walls and fences in their thousands. Many more, at lower densities, lived in the rainforests, foraging on craggy limestone outcrops, on sun-dappled branches and sometimes on the ground. None remain today. The urban population plummeted in the 1990s, a decade after Asian wolf snakes (*Lycodon capucinus*) arrived on a supply ship and multiplied in the settlement, reaching densities of 500 a hectare. The lizards survived in the rainforest, but as wolf snakes multiplied the skinks fell back until they lingered only at a remote location far from the settlement, Egeria Point, a rugged peninsula of limestone 2 kilometres long and 200 metres wide.

National park rangers acted just in time by collecting 66 blue-tails to found a captive colony. By 2010 they could find them only in one small part of Egeria Point that was no bigger than a tennis court. This spot still teemed with skinks in July, with 25 caught in 48 hours, but when the rangers returned a few weeks later none remained, and none were ever seen again in the wild. Five wolf snakes collected at Egeria Point around this time were dissected, and 3 had blue-tailed skinks inside. They became the first lizard in the world to be listed as extinct in the wild by the IUCN.

EXTINCT IN THE WILD
Primary Cause
INVASIVE SPECIES

2010s

The skinks prospered in captivity, reaching a population of 1,700, some of which are kept at Taronga Zoo in Sydney and some in outdoor enclosures on the island.

To improve their prospects, the skinks were released on 2 isles in the Cocos-Keeling Islands, far to the west of Christmas Island. Black rats first had to be eradicated. In 2019 about 300 skinks were freed on Pulu Blan and these did well, breeding within a year of arrival. Those released on Pulu Blan Madar did badly at first, until rangers realised there were yellow crazy ants (*Anoplolepis gracilipes*) in residence, which were killed with baits. To maximise genetic diversity, half of the skinks freed on each isle were brought from Taronga Zoo. Reared indoors, they had never seen sunshine before, but they survived just as well as those reared on Christmas Island

The Asian wolf snake is thought to be the main cause of the near loss of this species. Yellow crazy ants, giant centipedes (*Scolopendra subspinipes*), cats (*Felis catus*) and black rats (*Rattus rattus*) may have contributed. It is classified as extinct in the wild because the populations on the Cocos-Keeling Islands are outside the native range of the species.

Formal national status	Critically endangered
Expert assessment of extinction likelihood	Extinct in the wild (Chapple et al. 2019)
Expert assessment of primary threat	Wolf snake 82%, yellow crazy ant 12% (Woinarski et al. 2019)

Main sources: Geyle et al. 2021, Threatened Species Scientific Committee 2017b

Although saved from oblivion by captive breeding, the blue-tailed skink can't be returned to Christmas Island while wolf snakes remain rampant. Photo: © Bruce Thomson

"Species loss can be rapid, and species can slip from presumed security to extinction before a management response can be devised."
Jon-Paul Emery and colleagues (2021)

Photo: © Kirsty Faulkner Photography

Lister's gecko

(*Lepidodactylus listeri*)

This small pale lizard could easily be detected at night on Christmas Island by its brilliant brassy-orange eyeshine under torchlight. The geckoes were easy enough to find in 1979 when biologists Dr Hal Cogger and Ross Sadlier surveyed the island's reptiles. More than 80 were detected then, either on rainforest trees at night or behind bark on dead trees by day. When these biologists repeated the survey 21 years later no trace of Lister's geckoes could be found. Other biologists also failed to find it, including one who lifted bark on hundreds of trees. After no sightings for 2 decades, Cogger worried in 2006 that this little gecko might be extinct.

So, in 2010 people rejoiced when the species was rediscovered in pandanus groves and cabbage trees at a remote location, Egeria Point, the site furthest from the island's settlement and port. The geckoes were looked for there because it was the last site to support Christmas Island forest skinks and blue-tailed skinks, which were easier to find because they were active during the day. Egeria Point became the last holdout for all 3 species after Asian wolf snakes arrived on the island in the 1980s and spread, eating the lizards as their range expanded.

EXTINCT IN THE WILD
Primary Cause
INVASIVE SPECIES
2010s

With time running out for the geckoes, national park rangers worked at night in this difficult location to catch some – one ranger with a torch and laser pointer, the other charging into the forest to grab any gecko that was spotted. In 2010 the geckoes could be located along 2 kilometres of coastal vegetation, but by March 2011 they could be found only in a single spot. By October 2012, when the last wild gecko was sighted, the rangers had 43 geckoes – enough for a captive population.

Lister's gecko is classified as extinct in the wild, but it survives in captivity on Christmas Island and at Taronga Zoo in Sydney. While blue-tailed skinks have been returned to the wild in the Cocos-Keeling Islands, the gecko can't survive there because the vegetation is unsuitable, lacking tree holes and shedding bark, and there are larger tree-dwelling geckoes that would probably compete with and prey on it.

Wolf snakes are blamed for the extinction of this species, although it was probably disadvantaged as well by yellow crazy ants (*Anoplolepis gracilipes*), Asian house geckoes (*Hemidactylus frenatus*) and giant centipedes (*Scolopendra subspinipes*). A Lister's gecko was found inside a wolf snake caught at Egeria Point. Wolf snakes have eliminated 4 lizard species from the island but have not starved themselves out of a home because they still have introduced lizards and mice to eat.

Formal national status	Critically endangered
Expert assessment of extinction likelihood	Extinct in the wild (Chapple et al. 2019)
Expert assessment of primary threat	Wolf snake 82%, yellow crazy ant 12% (Woinarski et al. 2019)

Main sources: Andrew et al. 2018, Cogger 2005, 2006, Emery et al. 2021, Smith et al. 2012, Threatened Species Scientific Committee 2013, Tiernan 2018

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