Australian Government

Department of the Environment and Energy

Threat Abatement Plan

for infection of amphibians with chytrid fungus resulting in chytridiomycosis (2016)

Front cover photo: Symptoms of the terminal stages of chytridiomycosis include the half-closed eyes and generally depressed attitude seen in this frog, and an accumulation of cast-off skin (the greyish crescent shape near the top rear end of the frog). Image: Lee Berger.

Rear cover photo: The surface of the epithelium (outer layer of skin) of a frog with chytridiomycosis shows discharge tubes of spores of the fungus *Batrachochytrium dendrobatidis* emerging from the surface. Image: Lee Berger.

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Introduction

This threat abatement plan (TAP) has been developed to address the key threatening process 'Infection of amphibians with chytrid fungus resulting in chytridiomycosis', which is listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The TAP establishes a national framework to guide and coordinate Australia's response to chytrid fungus. It sets out the actions necessary to abate impacts of the listed key threatening process and was developed to comply with the requirements under the EPBC Act for the development of threat abatement plans. It identifies the research, management and other actions needed in Australia's response to this pathogen and replaces the threat abatement plan published in 2006 (Department of the Environment and Heritage, 2006).

The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but the making or adoption of this plan does not necessarily indicate the commitment of individual stakeholders to undertaking any specific actions. Proposed actions may be subject to modification over the life of the plan due to developments in understanding of the organism and its impacts.

The Australian Government Department of the Environment (the Department) is responsible for preparing this TAP. Its development has been informed by:

- the 2006 threat abatement plan (DEH, 2006) and its review and evaluation by the Australian Government in 2012 (DSEWPaC, 2012), and
- information provided by key stakeholders between 2011 and 2016.

Chytridiomycosis is an infectious disease that affects amphibians worldwide. It is caused by the chytrid fungus (*Batrachochytrium dendrobatidis*), a fungus capable of causing sporadic deaths in some amphibian populations and 100 per cent mortality in others. The disease has been implicated in the mass die-offs and species extinctions of frogs that have occurred since the 1970s. However, its origin remains uncertain and continues to be investigated (James *et al.,* 2009).

Eradication of this widespread and continuously present disease is not currently possible in wild amphibian populations. Given that the amphibian chytrid fungus has spread to almost all climatically suitable areas in eastern Australia, it has become increasingly important to: (1) better understand and mitigate the impact on key affected species in chytrid positive areas in order to prevent further extinctions from chytridiomycosis; and (2), monitor and mitigate the risk of spread and impact in high risk chytrid negative areas (e.g. Tasmanian Wilderness World Heritage Area). Many amphibian species persist despite infection with chytrid fungus, particularly in Western Australia — the reasons for this are not fully understood and warrant further investigation.

A modified approach to respond to the negative impacts of this disease on amphibians in Australia is needed; one that involves identifying and reducing impacts on key environmental assets (EPBC Act listed species and other priority amphibian species) and requires national coordination.

The Department recognises that a number of the state and territory governments that own land impacted by chytrid fungus have developed management plans and operational guides to abate this threat within their own jurisdictions. This TAP aims to complement state and territory approaches to managing chytridiomycosis.

Background – the previous threat abatement plan

'Infection of amphibians with chytrid fungus resulting in chytridiomycosis' was listed in July 2002 as a key threatening process under the EPBC Act. A key threatening process is defined as a process that 'threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community'. The first TAP for 'Infection of amphibians with chytrid fungus resulting in chytridiomycosis' was prepared in 2006 (DEH, 2006) and was reviewed in 2012 in accordance with requirements under section 279(2) of the EPBC Act.

The review of the 2006 TAP (DSEWPaC, 2012) was performed by the Department in consultation with key stakeholders and the members of the National Chytrid Working Group (convened by the Australian Government). It identified the progress against the plan's actions, objectives and goals over the period 2006–2012.

The review found that since 2006 some progress has been made in the implementation of the key actions identified in that TAP. For example: a national map of the distribution of chytridiomycosis is available; historical surveys have been completed; reliable diagnostic laboratory test protocols have been established; the biology of the pathogen has been investigated and is now much better understood; and many amphibian conservation managers in the state organisations are collaborating on captive breeding programs for threatened amphibians. The Australian Government also funded other projects targeted specifically to implement key TAP actions, such as: the development of hygiene protocols; guidelines for captive husbandry; a rapid in-field diagnostic test; a national disease strategy; and the formation of the National Chytrid Working Group (see Action 4.3).

However, the two main goals of the TAP were only partially achieved. Firstly, the further spread of amphibian chytrid fungus within Australia has slowed to some extent but surveys revealed that the disease had already reached almost all climatically suitable areas in Australia by 2006. Secondly, the impact of infection with amphibian chytrid fungus on populations that are currently infected has only been somewhat decreased.

As a result of the review, in December 2012, the Minister decided that:

a. the TAP should be revised to provide a more realistic and targeted plan which identifies and prioritises key actions and provides national leadership on multi-jurisdictional issues that cross-cut several species; and

b. a threat abatement advice should be prepared to provide direction on specific actions and research that are required to abate the threat to biodiversity from chytrid fungus.

This threat abatement plan

This document replaces the 2006 threat abatement plan. It incorporates the knowledge gained in the intervening years and has been modified in line with recommendations from the review. This plan was developed in consultation with key stakeholders and the members of the National Chytrid Working Group.

The threat abatement plan aims to guide the responsible use of public resources to achieve the best outcome for native amphibian species, ecological communities and other matters of national environmental significance (such as World Heritage Areas) threatened by chytrid fungus. The plan seeks to achieve these outcomes by recognising the opportunities and limitations that exist, and ensuring that field experience and research are used to further improve management of threatened amphibian species. The activities and priorities under the threat abatement plan will need to adapt to changes as they occur.

The TAP is expected to maintain the profile of the issue of amphibian chytrid fungus, provide direction for priority setting of national funding programs and guidance for state, territory and local governments to prioritise and support threat abatement actions in their management programs. It also contains information on priorities for research to enable universities and other research facilities to target research projects towards addressing gaps in knowledge.

Although the Minister had initially agreed to develop a separate threat abatement plan and threat abatement advice, the drafting of the two documents revealed significant duplication. Recent advances in the understanding of chytrid fungus enabled longer term research priorities to be developed and included as part of this TAP, with the result that the threat abatement advice became redundant.

Due to resource constraints and current priorities within the Department, the scientifically detailed background document that accompanied the previous TAP will not be updated.

1. Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis

1.1 Threat abatement plans and implementation

The EPBC Act prescribes the process, content and consultation to be followed when making a TAP to address a listed key threatening process. Under Section 270(A) of the EPBC Act, the Australian Government:

- develops TAPs where the Minister agrees that the making of a TAP is a feasible, efficient and effective way to abate a key threatening process.

Under Section 269 of the EPBC Act, the Australian Government:

- implements TAPs to the extent they apply in areas under Australian Government control and responsibility. Australian Government agencies must not take any actions that contravene a TAP.
- seeks the cooperation of the affected jurisdictions in situations where a TAP applies outside Australian Government areas in states or territories, with a view to jointly implementing the TAP.

The success of this TAP will depend on a high level of cooperation between all key stakeholders, including:

- Australian Government departments and agencies
- state and territory conservation and natural resource management agencies
- local governments
- research and zoological institutions
- the general community, including non-government environmental organisations and private conservation land management bodies, private landholders, Indigenous communities and natural resource management groups.

It will be important that land managers assess the threats and impacts of chytrid fungus and allocate adequate resources in order to work towards: effective on-ground prevention of spread and management of impacts; improving the effectiveness of prevention and management programs; and measuring and assessing outcomes.

In order to successfully implement this TAP, the Department will:

- coordinate its implementation as it applies to Commonwealth land and act in accordance with the provisions of the TAP, as required under the EPBC Act
- seek stronger coordination of national action on chytrid fungus
- draw on expertise from state and territory agencies and non-government organisations
- encourage involvement of key stakeholders and experts in chytrid-related research and management.

The Australian Government will monitor the uptake and effectiveness of management actions by all parties as part of a review of the TAP under Section 279 of the EPBC Act. Where the Australian Government and state and territory governments have mutual obligations, negotiation of appropriate actions and funding of management actions will be undertaken.

1.2 The pathogen – history and spread

First discovered in dead and dying frogs in Queensland in 1993, chytridiomycosis is a highly infectious disease of amphibians, caused by the amphibian chytrid fungus *Batrachochytrium dendrobatidis (B. dendrobatidis)*. Since 1993, research has shown that the fungus is widespread across Australia and has been present in the country since the 1970s. The disease is also found in Africa, the Americas, Europe, New Zealand and Asia (DSEWPaC, 2013).

Chytridiomycosis has been found in all Australian states and in the Australian Capital Territory, but not in the Northern Territory. Currently, it appears to be mainly confined to the relatively cool and wet areas of Australia, such as along the Great Dividing Range and adjacent coastal areas in the eastern mainland states of Queensland, New South Wales, Victoria, eastern and central Tasmania, southern South Australia, and south-western Western Australia. However, it has also been found in lowland streams in the Queensland Wet Tropics World Heritage Area.

Very few areas of suitable host environment remain uninfected in Australia—high risk chytrid negative areas include the World Heritage Area in south-west Tasmania and the Iron Range on Cape York. There are also some pockets of disease-free areas within infected regions due to the isolated nature of these amphibian populations (DSEWPaC, 2013) and relatively warm and saline wetlands may also provide refuges for local populations (Heard *et al.,* 2015)

Chytridiomycosis/*B. dendrobatidis* is listed as a notifiable disease in Australia's National List of Reportable Diseases of Aquatic Animals and by the World Organisation for Animal Health (OIE, formerly Office International des Epizooties) in the Aquatic Animal Health Code.

1.3 Impacts of Chytrid

1.3.1 Epidemiology and ecological impacts

Chytrid fungi typically live in water or soil, although some are parasites of plants, crustaceans and insects. They reproduce asexually and have spores that 'swim' through the water. The amphibian chytrid fungus is thought to be the most significant disease affecting biodiversity of vertebrates (Skerratt *et al*. 2007). Individual frogs contract the disease via contact with infected animals or contaminated water containing spores from infected animals (DSEWPaC, 2013).

Chytridiomycosis mostly affects amphibian species that are associated with permanent water (streams, moist bogs, soaks and ponds). The disease is strongly mitigated by high temperatures, and disease outbreaks tend to occur seasonally (Woodhams and Alford, 2005). However, much is still unknown about the fungus and the disease in the wild, including reasons for the death of hosts, how the fungus survives in the absence of amphibian populations and how it spreads (DSEWPaC, 2013). The fungus can infect freshwater crayfish in North America and this could be a mechanism for its spread and maintenance where amphibians are no longer present (McMahon *et al.,* 2012).

Interactions between the fungus and environmental factors are known to be important. For example, Australian upland populations of frogs have experienced the greatest number of declines and extinctions, leading to the suggestion that the cooler environmental and climatic conditions are more favourable for the growth and persistence of *B. dendrobatidis* (Scheele *et al.,* 2014). Amphibian immune systems may be compromised at low temperatures, and other stressors such as chemicals/pesticides or habitat destruction and disturbance could have synergistic effects on disease outcomes and species persistence at a regional level (Buck *et al.,* 2015).

The fungus invades the surface layers of the frog's skin, causing damage to the outer keratin layer. Amphibian skin is unique because it is physiologically active, allowing the skin to tightly regulate respiration, water, and electrolytes. The fungus kills amphibians by disrupting the normal function of the skin resulting in electrolyte depletion and osmotic imbalance (Voyles *et al.,* 2009). In some cases, this appears to cause suppression of the nervous system of the animal and breathing starts to slow down; death occurs when the nervous system reaches a point of paralysis and breathing and the heartbeat stops. Physical signs of paralysis can affect the nervous system as the disease progresses and in some individuals, the toes are curled and the head is tilted sharply forward by the time of death.

In some frog populations, the disease causes 100 per cent mortality, while in other populations, it causes very few deaths. Further, some amphibian species appear to be highly susceptible and die quickly, whilst others seem to be less susceptible (Kriger and Hero, 2006). With antifungal and supportive treatment, infected adult frogs and tadpoles in captive populations can fully recover from the disease.

Of note, the situation in Western Australia is quite different to the eastern states; although chytrid fungus is present in the majority of south-western Australian frog species, the impacts on these species have been non-catastrophic and stable populations persist. At present, it is not known why this difference between eastern and western Australia exists, but several theories including environmental differences and *B. dendrobatidis* strain variations have been suggested (Riley *et al.,* 2013).

1.3.2. Impacts on matters of national environmental significance

EPBC Act listed species, ecological communities and world heritage areas are matters of national environmental significance protected under the Act. This document has been prepared in compliance with existing management plans for relevant world heritage areas that provide habitat for amphibian species, e.g. the Tasmanian Wilderness World Heritage Area (DPIW, 2008).

'Infection of amphibians with chytrid fungus resulting in chytridiomycosis' is listed as a key threatening process under the EPBC Act.

The key threatening process is eligible for listing under the EPBC Act as it meets all criteria for listing:

a. *it could cause a native species or an ecological community to become eligible for listing in any category, other than conservation dependent; or*
b. *it could cause a listed threatened species or a listed threatened ecological community to become eligible to be listed in another category representing a higher degree of endangerment; or*
c. *it adversely affects 2 or more listed threatened species (other than conservation dependent species) or 2 or more listed threatened ecological communities.*

In Australia, the fungus has been directly implicated in the extinction of at least four species and the dramatic decline of at least 10 others, including *Litoria nannotis* (waterfall frog), *Litoria rheocola* (common mistfrog), *Litoria spenceri* (spotted tree frog) and *Litoria dayi* (previously *Nyctimystes dayi)* (lace-eyed tree frog). The four extinct species are from Queensland and include *Rheobatrachus silus* (southern gastric-brooding frog, last seen in 1981), *Rheobatrachus vitellinus* (northern gastric-brooding frog, 1985), *Taudactylus acutirostris* (sharp-snouted day frog, 1997) and *Taudactylus diurnus* (southern day frog, 1979). Many persisting species remain at lower abundance and have smaller distributions relative to their historical range. Other species, such as *P. pengilleyi* and *P. corroboree* are continuing to decline, with ongoing significant mortality decades after introduction. However, there are early signs that some frog populations are developing resistance to the chytrid fungus. For example, in parts of Queensland's Wet Tropics, *L. rheocola* and *L. nannotis* have survived at high altitude sites from which they had previously disappeared.

Table A provides a list of amphibian species that are considered to be under threat from the amphibian chytrid fungus, the immediate level of threat of possible extinction for these species (Skerratt *et al.,* 2016) and their current listing status under the EPBC Act (not all are currently listed). Table B lists the amphibian species that have gone extinct.

1.4. Managing the threat

While eradication of this widespread and continuously present disease has not been possible in wild amphibians, an array of well-targeted actions, combined with well-developed management plans based on current knowledge, can assist in reducing the impact of the disease on threatened amphibian populations. This is particularly the case for present and future captive breeding programs.

Currently there are no proven methods to control this disease in the wild (DSEWPaC, 2013). For threatened frog species, emergency measures are needed to increase population sizes through strategies including captive insurance colonies, and assisted colonisation. It is vital that coordinated captive management programs establish captive populations in a timely and strategic manner to avoid crisis situations and possible extinctions. Captive husbandry techniques for each at-risk species should be developed and documented and genetic banking undertaken.

Chytrid fungus is now established in most of the climatically suitable areas in Australia. Despite this, considerable efforts continue to protect the few remaining isolated uninfected amphibian populations, and some uninfected areas such as the Tasmanian Wilderness World Heritage Area (Murray *et al*. 2011a, 2011b). Some state governments have developed policy documents that contain strategies to limit the risk of spreading chytrid fungus. However, there has been little coordination between the states in policy development, risk analysis, surveying efforts for the presence and spread of chytrid fungus or limiting the impact of the disease once it has spread. Therefore, facilitation of coordination among jurisdictions would be of value in ensuring a consistent and high standard of threat abatement along with maximising cost efficiency. It would also help to identify if any high-risk areas have been overlooked to date.

Understanding the ecology and characteristics of the disease and how it relates to general environmental conditions, such as temperature, is important when developing effective management strategies (Alford *et al.*, 2010). The mechanisms that underlie some amphibian species' resistance/ immunity (Clemann *et al.*, 2009/10) and ability to co-exist with chytrid fungus at the species and individual level and the role this apparent resistance plays in allowing populations to persist and even recover from the impact of chytridiomycosis (Brannelly *et al.,* 2015) (Rowley and Alford, 2013) should be further investigated. This knowledge could be used to improve management strategies, which are important for ensuring successful reintroductions and long term threat abatement.

As chytrid fungus strains vary in virulence (Rosenblum *et al.*, 2013), understanding the differences in strains, mapping their location and reducing the risk of spread between infected areas is also important (Murray *et al.*, 2011b). Developing a greater understanding of how the impacts of chytridiomycosis on infected wild populations can be better mitigated would help reduce the impact of the disease.

Monitoring and surveillance is necessary to:

- determine the impact of the disease on frog populations, including those populations that appear to be recovering naturally;

- detect new outbreaks in currently uninfected populations or locations of unknown disease status; and
- monitor the progress and success of management strategies (including broader environmental conditions) in order to provide the necessary feedback for adaptive management.

1.5. Climate Change

It is difficult to predict how a changing climate will impact the threat posed by the chytrid fungus, but it is likely that the distribution of the fungus and virulence of chytridiomycosis disease will be somewhat altered as temperatures increase and rainfall patterns change. Further, environmental conditions have strong effects on host-pathogen dynamics (Woodhams and Alford, 2005). With predicted average temperature increases of between 1°C and 5°C in Australia by the year 2070 (CSIRO and Bureau of Meteorology 2007–2012), it is possible that chytrid fungus will extend into areas that were previously unsuitable for the establishment of the pathogen. In contrast, some areas predicted to have higher temperatures and reduced rainfall could become less conducive to the disease. Some models suggest that higher temperatures associated with climate change may reduce the range suitable for chytrid fungus, as some areas will become too warm for chytrid development and transmission, although range expansion may occur in the long term (Rodder *et al*., 2010).

The effects of climate change are likely to be variable among species and sites. For example, increases in cloud or canopy cover could increase the effects of the disease on susceptible individuals (Puschendorf *et al*., 2011) but higher temperatures may lower the overall mortality rate (Rowley and Alford, 2013). The effect that changes in hydrology may have on the impact of chytrid fungus on susceptible amphibians (Sapsford *et al.*, 2013) is even harder to predict than changes in air temperature. Additionally, the impacts of climate change, such as higher temperatures, more erratic rainfall, more disease vectors and reduction in the food supply (i.e. insects), may also increase amphibian susceptibility to chytrid fungus, due to potential increases in background environmental stress.

2. Objectives and actions

The overarching goal of this TAP is to minimise the adverse impacts of amphibian chytrid fungus on affected native species and ecological communities. To achieve this goal, the TAP has four main objectives that were developed in consultation with experts. These objectives are to:

1. improve understanding of the extent and impact of infection by amphibian chytrid fungus and reduce its spread to uninfected areas and populations
2. identify and prioritise key threatened amphibian species, populations and geographical areas and improve their level of protection by implementing coordinated, cost-effective on-ground management strategies
3. facilitate collaborative applied research that can be used to inform and support improved management of amphibian chytrid fungus
4. build scientific capacity and promote communication among stakeholders.

Each objective is accompanied by a set of actions that, when implemented, will help to achieve the goal of the TAP. Performance indicators (outcomes and outputs) have been established for each objective.

Objective 1: Improve understanding of the extent and impact of infection by amphibian chytrid fungus and reduce its spread to uninfected areas and populations

Gaining information on the extent of infection and the location of uninfected populations and areas will help to inform the planning of surveillance and management activities.

Action	Priority/ timeframe	Outcome/output
Action 1.1: Understand impacts of chytrid fungus on priority species (this links to Action 2.1: Identify species at high risk from chytrid fungus for priority management) Stakeholders to undertake population monitoring of at-risk species to determine impacts of chytrid fungus on these species. This could include targeted surveys for species that have not been recently detected but may persist as remnant populations. Improved mapping and monitoring that incorporates changes in population distribution, density and impacts over time may also increase understanding of the potential impact. Given that the amphibian chytrid fungus has spread to almost all climatically suitable areas in eastern Australia, it is important to better understand the impact on priority species and monitor and mitigate the risk of spread and impact in high risk areas where chytrid fungus is not currently known to be present (e.g. Tasmanian Wilderness World Heritage Area). It is also important to consider the potential effects of habitat destruction, climate change and other environmental factors (such as chemicals, salinity or groundwater draw-down) on the spread of chytrid fungus and the long term impacts on priority species, which are likely to be variable among species and sites.	High priority Years 1–5	Monitoring of the impacts of chytrid fungus on priority species is undertaken and published.
Action 1.2: Continue mapping the distribution of chytridiomycosis (and chytrid fungus) at a regional scale to inform appropriate planning and adaptive management approaches Stakeholders to continue ongoing survey work and mapping locations of chytrid-infected and chytrid-free areas (preferably at a regional or catchment scale). This would build on the work already completed under the 2006 TAP, such as the national distribution map developed in 2010 by Murray *et al.* (Attachment A) and the survey protocols developed by Skerratt *et al.* (2007, 2010). Surveys of amphibian populations in Western Australia may require the development of protocols more suited to the local conditions— stakeholders to develop appropriate protocols if necessary. Stakeholders to undertake targeted surveys to determine the presence of chytrid fungus across the range of priority species identified in Action 2.1. Regularly updating maps and reporting new infections (to Wildlife Health Australia) would assist federal and state agencies in monitoring the effectiveness of management programs. The identification and mapping of different chytrid strains should be undertaken to inform distribution modelling and risk assessments of chytrid fungus, and to identify where knowledge gaps exist.	Medium priority for targeted surveys of strains and priority species Years 1–5 Low priority for general surveys	Appropriate survey protocols agreed and used by all affected jurisdictions to keep current the national map of the distribution of chytridiomycosis (at Attachment A) and develop regional and/or catchment scale maps. Identification and mapping of chytrid strains is undertaken. Targeted surveys of the priority species identified in Action 2.1 are undertaken

Action 1.3: Develop and implement amphibian translocation strategies to prevent the accidental spread of the fungus Ensure that measures to prevent the spread of chytrid fungus are included in amphibian translocation strategies developed for conservation purposes, such as: i. the release of captive populations (see Action 2.3); ii. reintroduction programs; and iii. relocation of populations to mitigate habitat loss. The development and implementation of translocation strategies by the states and territories should be consistent with EPBC Act approved recovery plans and relevant policies. Strategies should include measures to prevent the introduction of amphibian chytrid fungus into naïve areas and populations and to investigate whether improved quarantine protocols could allow the release of animals that may have been brought into captivity for breeding programs or research. Although this action is particularly important in areas that are chytrid-free (such as the Tasmanian Wilderness World Heritage Area), it may also apply to widely separated infected areas of Australia where there is uncertainty about the levels of risk due to potential differences in strain virulence. A precautionary approach should be adopted for these areas i.e. no movement of infected amphibians between widely separated infected regions should occur until appropriately assessed under an approved translocation strategy. Information on how to manage accidentally translocated amphibians (such as in agricultural produce, e.g. bananas, bagged lettuce) needs to be made available to industry, wildlife professionals and the general community. This should be included in the Communication Strategy (see Action 4.1)	Medium priority Years 1–3	Translocation strategies, where not already developed and implemented, agreed and implemented by all affected jurisdictions.
Action 1.4: Ensure intra-state and inter-state implementation of hygiene protocols, focusing on high priority areas Preventing the spread of chytrid fungus into chytrid-free high priority areas is vital to the continued existence of some threatened amphibian species and populations. Implementing effective hygiene protocols will reduce the chances of the amphibian chytrid fungus spreading into these areas. Hygiene protocols and associated education programs have been developed but are yet to be implemented in a coordinated manner across states. These protocols need to be included in management strategies at all levels. (See Action 2.2) Government departments to ensure that licences and permits for research (including flora or fauna studies) or other activities that have the potential to transmit amphibian chytrid fungus into chytrid-free areas, include conditions that require the use of appropriate disinfection strategies between sites. Government departments to ensure that persons undertaking recreational and commercial activities, such as bushwalking, fishing, mountain biking, four wheel driving or leading tour groups, that have the potential to transmit amphibian chytrid fungus into chytridiomycosis-free areas, are made aware of their requirements to use appropriate disinfection strategies between sites. Community access to information about best-practice hygiene and spread-prevention techniques should be included in the Communication Strategy (see Action 4.1).	Medium priority Years 1–4	Appropriate hygiene protocols implemented by all states and provided to land managers, contractors, recreational users, commercial groups and affected communities for implementation.

Objective 2: Identify and prioritise key threatened amphibian species, populations and geographical areas and improve their level of protection by implementing coordinated, cost-effective, on-ground management strategies

This objective aims to identify and prioritise amphibian species and populations that may need protection and prevent additional amphibian species from going extinct due to the impacts of chytrid fungus. It also aims to identify and prioritise the particularly sensitive geographical areas and populations at all levels (Commonwealth, state and territory, regional and local) where management activities need to be focused, such as world heritage areas.

Monitoring and management activities also need to be conducted in a coordinated manner to maximise limited resources and achieve effective outcomes. This includes sharing information, coordinating activities across jurisdictions, and applying coordinated, scientifically-based management to high-priority areas that contain threatened species. The Australian Government has a responsibility to manage the impacts of chytrid fungus on Commonwealth land and to protect matters of national environmental significance, such as the contribution of existing amphibian species and populations to World Heritage values under the EPBC Act.

A number of guidelines and protocols are required for the successful coordination of management activities to reduce the impact of chytrid fungus. Although many state governments have developed policy documents that contain management strategies, there is a lack of coordination between states in their application and implementation. Linking chytrid management strategies to threatened species recovery plans and relevant habitat management and conservation plans would help to coordinate conservation efforts and maintain awareness of any listed species or ecological communities potentially affected by management actions. The EPBC Act listed Threatened Ecological Community — “Alpine *Sphagnum* Bogs and Associated Fens” is of particular interest due to the presence of many listed threatened frog species. The National Recovery Plan for the Alpine Sphagnum Bogs and Associated Fens can be found at http://www.environment.gov.au/biodiversity/threatened/publications/recovery/alpine-sphagnum-bogs-associated-fens

Action	Priority/ timeframe	Outcome/output
Action 2.1: Identify species at high risk from chytrid fungus for priority management (this links to Action 1.1: understanding the impacts of chytrid fungus on priority species, and to Action 2.3 below) Continue risk assessments to identify priority native amphibian species that are threatened or particularly vulnerable to chytrid fungus (see Table A for species currently considered to be under immediate threat from chytrid (Skerratt *et al.,* 2016) and their listing status under the EPBC Act). Species not currently listed under the EPBC Act but considered to have the potential to become threatened due to the spread and subsequent impacts of chytrid fungus need to be further assessed e.g. the Tasmanian Tree Frog *Litoria burrowsae*. State environment departments, biodiversity conservation managers and researchers to lead monitoring and surveillance of the identified high priority species of amphibians to inform risk assessments and subsequent management decisions (links to Trigger Action Response Plan in Action 3.6).	High priority Years 1–2	Priority species identified for protection.
Action 2.2: Implement biosecurity measures around high priority	High	Key areas

areas and identify any additional chytrid-free areas for protection The state environment departments, biodiversity conservation managers and researchers to develop and implement effective biosecurity measures and contingency plans (see Action 1.4) to protect areas that are known to be of high biodiversity value and are ranked high priority for amphibian chytrid fungus exclusion, such as the Tasmanian Wilderness and Gondwana Rainforest World Heritage Areas. The state environment departments, biodiversity conservation managers and researchers to identify any additional areas that are of high biodiversity value and are ranked high priority for amphibian chytrid fungus exclusion.	priority Years 1–2	identified and effective biosecurity measures implemented. Contingency plans prepared.
Action 2.3: Protect at risk species by establishing insurance populations of key threatened species Expand knowledge of husbandry practices, and infrastructure, for captive breeding of amphibians, particularly with respect to species that are threatened or particularly vulnerable to chytrid fungus (as identified in Action 2.1). This work should be undertaken in a strategic manner, based on risk assessments, in order to avoid potential crisis situations (i.e. few individuals of a species remaining resulting in non-sustainable population levels) – Links to Action 3.6. Establish captive breeding, captive husbandry and/or assisted colonisation programs across states and territories. Conservation managers to coordinate these activities where possible in order to maximise the outcomes and share knowledge.	High priority Years 1–5	Insurance populations of key threatened species established. Husbandry protocols developed for all species that are vulnerable to chytrid fungus. No additional amphibian species go extinct due to chytrid fungus.
Action 2.4: Genetic banking and cryopreservation of high priority species Genetic banks for threatened Australian amphibian species to be developed at appropriate cryopreservation facilities (Mahony and Clulow) by state environment departments, biodiversity conservation managers and researchers, prioritising species most at risk (as identified in Action 2.1). This action supports Action 2.3 (captive husbandry) as it can be used to expand the gene pool of captive populations. The banked specimens may also be required as a last line of defence to prevent the extinction of critically endangered amphibian species. Decisions about when cryopreservation should be undertaken could be included in the Trigger Action Response Plan outlined in Action 3.6.	High priority Years 1–3	Genetic banks for threatened native amphibian species established at appropriate cryopreservation facilities.
Action 2.5: Include chytrid fungus management strategies in amphibian recovery plans and habitat management plans to achieve better coordination of conservation efforts. Ensure recovery plans are enacted for all high priority species threatened by chytrid fungus. As new amphibian recovery plans are developed, the Australian Government Department of the Environment should ensure that management strategies for chytrid fungus are incorporated. The recovery plans should include: • assessing species vulnerability to chytrid fungus; • monitoring, detection and determining impact of chytrid fungus; and • identifying actions to address the arrival of the chytrid fungus in	High priority Years 1–5	Frog recovery plans enacted for threatened species and include strategies to manage chytridiomycosis and improve coordination across regions. Relevant habitat management and conservation plans include

the case of chytridiomycosis-free populations or population decline for chytridiomycosis-positive populations. The states and territories to ensure that, as new amphibian recovery plans are developed at the state/territory level, strategies to manage chytrid fungus are incorporated, where appropriate. All recovery plans should aim to achieve improved coordination of conservation efforts for amphibians impacted by chytrid fungus across populations, regions and species. Develop and enact recovery programs for all high priority species threatened by chytrid fungus. Consider inclusion of chytrid fungus management strategies in relevant habitat management and conservation plans (such as the National Guidelines for Ramsar Wetlands, conservation advices, environmental watering plans or water quality plans)		consideration of chytrid management strategies.
Action 2.6: Develop regional management plans and reporting framework States to develop and implement regional management plans and programs for listed threatened and other high priority amphibian species. States to develop a process to evaluate and report on the implementation of management actions. This may help to maintain momentum, motivation and direction. Regular reporting on the implementation of management programs will help to identify effective methodologies and prioritise any key areas requiring greater management effort. Agreement on monitoring and evaluation methods will assist with the implementation of procedures and processes. This could include appropriate reporting at national, state, territory and regional levels and the use of existing frameworks such as MERI (monitoring, evaluation, reporting and improvement).	Medium priority Years 1–2	Regional management plans prepared and implemented by jurisdictions. Reporting and evaluation process implemented by states.

Objective 3: Facilitate collaborative applied research that can be used to inform and support improved management of amphibian chytrid fungus

To develop the most effective management strategies for abating the threat of chytrid fungus and ensure the continued existence of sustainable populations of at-risk amphibians in Australia, joint/collaborative research will be important to inform and update key knowledge of the pathogen. Despite improved understanding of the chytrid fungus through ongoing research effort, there are still significant gaps in knowledge that are hampering the success of management programs. This includes knowledge on: the different strains of the fungus; levels of virulence; mechanisms for resistance to the disease; treatment options; husbandry methods for individual species; environmental toxins and the potential of other species (e.g. freshwater crayfish) to act as reservoirs or vectors for transmission of the fungus.

Without this information, there is a risk that management efforts will be misdirected or ineffective.

Action	Priority/ timeframe	Outcome/output

Action 3.1: Develop assisted colonisation strategies to aid recovery of amphibian populations impacted by chytrid fungus Assisted colonisation is an effective and relatively low cost management option to potentially improve numbers of at-risk priority amphibian species (identified in Actions 1.1 and 2.1). Research is needed to develop assisted colonisation strategies for priority species. Consideration should be given to the identification of the most advantageous low-risk sites based on appropriate environment conditions for the target amphibian species, environmental unsuitability for the pathogen and the potential role of reservoir hosts. Research should include trialing interventions that improve survival and recruitment rates, such as field enclosures that keep out chytrid fungus, or by providing permanent water sources that support increased and sustained recruitment (Scheele, 2015)	High priority 1–5 years	Assisted colonisation is evaluated for success and broad applicability to improve numbers of at-risk priority amphibian species.
Action 3.2: Investigate individual and population level resistance and persistence to abate the threat of chytrid fungus • **Understand mechanisms for resistance, including the effects of environmental factors** • **Identify and select individuals and populations that demonstrate resistance** • **Investigate factors that allow populations to persist and coexist with chytrid fungus, including the apparent difference in resistance and persistence of amphibian species in Western Australia compared to those on the east coast** • **Investigate the applicability of bioaugmentation with beneficial microbes (possibly probiotics) to facilitate species coexistence with chytrid fungus** The mechanisms underlying individual resistance to chytrid are not understood and should be investigated across species including their role in allowing populations to persist, coexist and even recover from the impacts of chytrid. Potential for behavioural selection should be investigated. The virulence of the pathogen varies between species, populations and geography and this aspect should also be investigated, including the presence of toxins in the environment. Bioaugmentation is an active area of research for many chytridiomycosis-threatened species globally and holds some promise (Yasumiba *et al.,* 2015). This action should include host bioaugmentation (possibly using probiotics) as well as environmental applications of microbes that may consume chytrid fungus and reduce its impact on amphibians.	High priority 1–5 years	Mechanisms for resistance to, and population coexistence with, chytrid fungus are understood. Potential for targeted selection of individuals is determined. Effectiveness of bioaugmentation for preventing population declines understood for priority species.

Action 3.3: Investigate the virulence of the pathogen and potential for pathogen modification/selection Research to improve the understanding of the differences between the various strains of chytrid fungus is urgently required including investigations into what strain(s) of chytrid fungus is/are present in Western Australia. The virulence of the pathogen varies between strains and therefore the level of risk posed by each strain is variable. It is important to understand whether the pathogen can be modified or selected to be less virulent. The potential role for biocontrol agents such as fungus viruses and predators needs exploration.	High priority 1–5 years	The impacts and level of risk posed by various strains of the fungus is determined. The potential for pathogen virulence being selected for or modified (including biocontrol) sufficiently to lead to recovery of species is determined. The strain(s) of chytrid present in Western Australia are identified.
Action 3.4: Further development of treatment protocols for infected amphibians and areas Continued research to determine the best treatments for individual species and whether contained areas in the environment can be treated to abate the threat of chytrid fungus, e.g. by spraying these areas with antifungals combined with environmental disinfection (Bosch *et al.,* 2015). This action complements some of the actions included in the recovery plans for each amphibian species listed under the EPBC Act. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species. Further information on recovery plans can be found at http://www.environment.gov.au/topics/biodiversity/threatened-species-ecological-communities/recovery-plans	High priority 1–3 years	Optimal treatments for priority species are identified. Treatment of contained areas in the environment is evaluated for feasibility and effectiveness in abating the threat of chytrid fungus.
Action 3.5: Research to develop husbandry protocols for captive bred populations of priority species Husbandry methods for establishing captive insurance populations of at-risk priority species need to be further researched and developed. This work will support Action 2.3 and priorities should be decided based on the risk assessment process in Action 2.1 and the population impact assessments in Action 1.1. This action complements some of the actions included in the recovery plans for each amphibian species listed under the EPBC Act.	High priority 1–3 years	Optimal husbandry for establishing captive insurance colonies for priority species is determined.
Action 3.6: Determine the trigger points required for the implementation of management actions that prevent extinction	High priority 1–5 years	Risk factors for extinction or drastic

of a population or species (links to Action 2.3) Investigate why apparently "secure" populations occur within infected areas (while others have been extirpated) and whether they may become vulnerable due to shifts in factors associated with their persistence, including habitat, climate, reservoir hosts, immunity and pathogen virulence. Investigate vulnerable “edge of range” populations and assess the risks to these populations under various climate change scenarios. Determine trigger points for establishing a genetically-stable captive breeding program to prevent potential extinctions, based on risk of extinction, population trajectories, or population size. Develop a Trigger Action Response Plan.		reduction in vulnerable populations and species are determined. Trigger points for management actions to prevent extinctions are determined. Trigger Action Response Plan is developed.
Action 3.7: Understanding chytrid fungus in the environment and the effects of environment/habitat modification Continue research to improve diagnostic capability, particularly rapid diagnostic in-field tests (Phalen *et al.*, 2011), for detecting the presence of the chytrid fungus on hosts and in environmental water samples. Various options should be investigated including further testing of the Loop-Mediated Isothermal Amplification (LAMP) test. Research is required to provide further insight into pathogenesis including the factors affecting the virulence of chytrid fungus under various environmental conditions. Research should continue to build on work already undertaken in south-east Australia (Scheele *et al*., 2014) into how these factors could be manipulated to abate the threat. Undertake research to answer high priority questions about chytrid fungus in the environment, particularly relating to transmission, possible amphibian and non-amphibian vectors (including natural and unnatural movements), and amphibian and non-amphibian carriers/hosts (e.g. freshwater crayfish). The levels of background chemicals in the environment and toxicology of affected amphibians also should be investigated.	Med priority 1–5 years	Diagnostic capability is improved and the field application of a rapid test is determined. Environmental factors affecting chytrid fungus are identified and their manipulation is evaluated for feasibility and effectiveness in abating the threat. Transmission via vectors and hosts is better understood.

Objective 4: Build scientific capacity and promote communication among stakeholders

Building coordination and communication between key stakeholders and researchers is expected to improve the likelihood of the success of this TAP. In particular, this will assist by facilitating access to data and alerting stakeholders to new sites of infection, as well as encouraging increased support for implementing management actions. For researchers, it would allow greater collaboration, build capacity and reduce unintentional duplication of efforts.

To achieve improvements and maximum efficiency in management activities, it is accepted that sharing information and coordinating activities across jurisdictions will result in the greatest conservation gains. Applying coordinated, scientifically-based management to high-priority areas that contain key threatened species is vitally important to protect these amphibian species.

Action	Priority/ timeframe	Outcome/output
Action 4.1: Develop a communication strategy that will contribute to abating the threat of amphibian chytrid fungus The Department to promote information exchange between researchers/key stakeholders and support the development of a communication strategy on abating the threat of amphibian chytrid fungus. National Chytrid Working Group to lead on developing and implementing the communication strategy. This communication strategy should include: ▪ techniques to encourage collaborative research on chytrid fungus and its impact on amphibian populations, across various disciplines and institutions ▪ methods to disseminate information to stakeholders, including reporting detection of outbreaks, to assist in the coordination of responses to outbreaks, particularly in chytridiomycosis-free areas ▪ methods to educate and inform the community (including key groups such as wildlife carers, frog biologists, veterinarians, and commercial and recreational users, including bushwalkers, 4WD operators and tour groups) about existing legislation and regulations regarding chytrid, basic disease management and the risks of transporting potentially infected amphibians, water and other transmitting agents. Information on the Australian Registry of Wildlife Health public website now includes the content of the former Amphibian Disease Home Page. This webpage (http://www.arwh.org/amphibian-dz-homepage) could be updated, as required, to assist in this process. ▪ guidelines on appropriate information and signage to be placed at entrances to national parks, forestry reserves, and other areas containing water bodies – particularly in identified key areas and wilderness zones. Wash down facilities to be provided, where needed.	High priority Years 1–3	Communication strategy developed and implemented.
Action 4.2: Support the development/provision of a central information storage site where government, stakeholders and researchers can upload and access data (part of communication strategy Action 4.1) Stakeholders to lead on the provision of an agreed central information/data storage site that allows researchers and stakeholders to upload relevant information such as research data and papers that can be shared with other researchers and key stakeholders. This should also act as a coordinated national database for chytrid survey results that could inform reporting processes at all levels of government.	Med priority Years 1–5	Central database developed and relevant data provided to stakeholders.
Action 4.3: Support the capacity of stakeholders to participate in the management of amphibian chytrid fungus through the National Chytrid Working Group	High priority	National Chytrid Working Group to have met annually

The Department to support the 'National Chytrid Working Group' whose members are amphibian managers working to abate the threat from amphibian chytrid fungus. The members of this group have technical and practical knowledge in chytrid and amphibian management and include key stakeholders from states and territories where chytrid fungus is recognised as a threat to amphibians. This group will provide advice and recommendations on resources and priorities for actions to abate the threat of amphibian chytrid fungus in Australia and also provide key contact points to improve information flow and communication between states, regions and local groups.	Years 1–5	and provided timely advice on progress and actions to abate the threat of chytrid fungus.

3. Duration, Review, Funding and Implementation

3.1. Duration and review of the plan

Section 279 of the EPBC Act provides for the review of this TAP at any time and requires that it be reviewed by the Minister at intervals of no longer than five years. Following the review of TAP the Minister's scientific advisory committee (the Threatened Species Scientific Committee), will be provided with updates of actions taken under this TAP to aid them in advising the Minister on the effectiveness of the TAP in abating the key threatening process.

3.2. Funding and implementation

It is important to note that TAPs are not linked directly to any Australian Government funding programs. Each financial year, the Australian Government funds TAP development and implementation as part of a broader budget outcome related to biodiversity conservation (www.environment.gov.au/about/publications/budget/index.html). The Department allocates its annual budget to a range of competing biodiversity conservation priorities.

This TAP provides a framework for undertaking targeted priority actions. Budgetary and other constraints may affect the achievement of the objectives of this plan, and as knowledge changes, proposed actions may be modified over the life of the plan. The Commonwealth is committed, via the EPBC Act, to implement the threat abatement plan to the extent to which it applies in Commonwealth areas. However, it should be noted that the Australian Government is unable to provide funding to cover all actions in this threat abatement plan across all of Australia and requires financial and implementation support from stakeholders. Partnerships amongst and between governments, non-government organisations, community groups and individuals will be fundamental to successfully delivering significant reductions in the threat posed by chytrid.

Investment in many of the TAP actions will be determined by the level of resources that stakeholders commit to management of the problem. The Australian Government recognises that the capacity of each state or territory government to implement this TAP will be dependent on the resources of that state or territory and the methods of implementation they choose to adopt.

Given the extent of the chytrid fungus across Australia, an indicative estimate of the costs involved to undertake the actions outlined in this plan is provided below. The costs provided will be highly variable depending on facilities, location and availability of skilled personnel. Some projects may be suitable to be conducted by PhD students (or even volunteers) at a lower cost. Anyone looking to implement an action is strongly recommended to undertake their own budget exercise for their particular circumstances and outcomes sought.

Action	Costs anticipated or known at the time of TAP development for action items	Estimated total cost across TAP
Monitoring and survey activities.	Costs will be dependent on the number and location of sites and species surveyed and the type of monitoring program required.	$2,800,000 over 5 years.

Action	Costs anticipated or known at the time of TAP development for action items	Estimated total cost across TAP
Development of a Communication Strategy and community education.	$250,000 to develop Communication Strategy + $30,000 for general promotion per year.	$250,000 for initial development of Strategy. $150,000 over 5 years for community education.
Continued identification and prioritisation of at-risk species for protection — through risk assessment process.	$25,000 per risk assessment, total costs will depend on number of assessments required.	Possibly $200,000 over 2 years.
Identification of priority areas for protection.	$80,000 per regional review to identify priority areas, total costs will depend on number of reviews required.	Possibly up to $400,000.
Development of regional management plans and establishment of recovery programs.	$10,000 for each regional plan, total costs will depend on number of plans required. $280,000 per species to develop and implement recovery program.	Possibly up to $200,000 for 20 Regional plans. $2,000,000 for 7 recovery programs over 5 years.
Development and implementation of translocation and assisted colonisation strategies and hygiene protocols.	Costs will be dependent on the requirements of the individual species and availability of suitable facilities. $150,000–$250,000 per species to develop and implement translocation and assisted colonisation strategies and protocols.	$1,500,000 over 5 years.
Development of a Trigger Action Response Plan (to prevent extinctions).	$80,000	$80,000
Development of husbandry protocols and establishment of insurance populations for high priority species.	Costs will be dependent on the requirements of the individual species and availability of suitable facilities. $150,000–$250,000 per species to develop husbandry protocols and establish insurance populations.	$1,500,000 over 5 years.
Genetic banking of high priority species.	$35,000-$85,000 per species (500 individuals per species) to preserve genetic material and $12,500 per year to maintain samples at appropriate facility.	$97,500-$147,500 per species over 5 years.

Action	Costs anticipated or known at the time of TAP development for action items	Estimated total cost across TAP
Research projects, including investigation of resistance, virulence of individual strains and environmental factors.	$150,000–$250,000 annually per researcher. Costs to be determined for each project.	$4,200,000 over 5 years.
Development of coordinated reporting mechanisms and central data storage site.	$100,000 to establish national database. $10,000 per state/territory for reporting annually for 5 years.	$100,000 to initially establish database. $50,000 per state/territory over 5 years.
Support National Chytrid Working Group.	$5,000 to $10,000 annually to facilitate meetings.	$50,000 over 5 years.

Table A: Amphibian species that are currently assessed to be under threat from the impacts of amphibian chytrid fungus

Scientific name	Common name	Current status (extinction risk level)	EPBC Act status	Distribution
Amphibians				
Litoria nyakalensis	Mountain mistfrog	Possibly extinct	CE	QLD
Taudactylus rheophilus	Tinkling frog	Possibly extinct	E	QLD
Litoria piperata	Peppered tree frog	Possibly extinct	V	NSW
Litoria lorica	Armoured mistfrog	High	CE	QLD
Pseudophryne corroboree	Southern corroboree frog	High	CE	NSW
Pseudophryne pengilleyi	Northern corroboree frog	High	CE	ACT/NSW
Taudactylus pleione	Kroombit tinker frog/ Pleione's torrent frog	High	CE	QLD
Litoria castanea	Yellow-spotted tree frog/ yellow-spotted bell frog	High	E	NSW
Litoria spenceri	Spotted tree frog	High	E	VIC/NSW
Philoria frosti	Baw Baw Frog	High	E	VIC
Litoria burrowsae	Tasmanian tree frog	High	Not listed	TAS
Litoria myola	Kuranda tree frog	Moderate-High	E	QLD
Mixophyes fleayi	Fleay's frog	Moderate	E	QLD/NSW
Litoria dayi	Lace-eyed tree frog/ Australian lacelid	Moderate	E	QLD
Taudactylus eungellensis	Eungella day frog	Moderate	E	QLD
Heleioporus australiacus	Giant burrowing frog	Moderate	V	NSW/VIC
Litoria littlejohni	Littlejohn's tree frog/ Heath frog	Moderate	V	VIC/NSW
Litoria raniformis	Growling grass frog/southern bell frog/ green and golden frog/ warty swamp frog	Moderate	V	VIC/TAS/NSW/ SA
Mixophyes balbus	Stuttering frog/ southern barred frog (In Vic. only)	Moderate	V	VIC/NSW
Litoria longirostis	Long-snouted frog	Moderate	Not listed	QLD
Crinia nimbus	Moss froglet	Moderate	Not listed	TAS
Pseudophryne semiarmorata	Southern toadlet	Moderate	Not listed	VIC/TAS
Uperoleia martini	Martin's toadlet	Moderate	Not listed	VIC/NSW
Pseudophryne bibroni	Bibron's toadlet	Moderate	Not listed	VIC/NSW
Litoria kroombitensis	Kroombit tree frog	Moderate	Not listed	QLD
Litoria nannotis	Waterfall frog/ torrent tree frog	Lower-Moderate	E	QLD
Litoria rheocola	Common mistfrog	Lower-Moderate	E	QLD
Litoria pearsoniana	Pearson's tree frog/ Cascade tree frog	Lower-Moderate	Not listed	QLD

Litoria aurea	Green and golden bell frog	Lower-Moderate	V	VIC/NSW
Mixophyes iteratus	Giant barred frog/ southern barred frog	Lower	E	QLD/NSW
Litoria booroolongensis	Booroolong frog	Lower	E	VIC/NSW
Adelotus brevis	Tusked frog	Lower	Not listed	QLD/NSW
Litoria serrata	Green-eyed tree frog	Lower	Not listed	QLD

CE = critically endangered; E = endangered; V = vulnerable

Table B: Amphibian species listed under the EPBC Act as having gone extinct from the impacts of amphibian chytrid fungus

Scientific name	Common name	EPBC Act status
Rheobatrachus silus	southern gastric-brooding frog	EX
Rheobatrachus vitellinus	northern gastric-brooding frog/Eungella gastric-brooding frog	EX
Taudactylus acutirostris	sharp-snouted day frog/ sharp-snouted torrent frog	EX
Taudactylus diurnus	southern day frog/ Mt Glorious torrent frog	EX

Glossary

Assisted colonisation	Helping species colonise areas within or immediately adjacent to their current or former ranges that appear to be suitable habitats for that species.
B. dendrobatidis	*Batrachochytrium dendrobatidis (Bd)*
Chytridiomycosis	The state of being infected with *Batrachochytrium dendrobatidis*. Amphibians can have chytridiomycosis without showing clinical signs (aclinical chytridiomycosis) or can show clinical signs (mild, severe) or death. The term was proposed by Berger *et al.* (1998).
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EPBC Act	The *Environment Protection and Biodiversity Conservation Act 1999,* the Australian Government's environment legislation.
Genetic banking	The freezing of living tissue such as sperm and eggs at very low temperatures to preserve living cells for conservation purposes.
Key threatening process	A threatening process listed under the EPBC Act that meets any of the following criteria: • could cause a native species or an ecological community to become eligible for listing in any category, other than conservation dependent • could cause a listed threatened species or a listed threatened ecological community to become eligible to be listed in another category representing a higher degree of endangerment • adversely affects two or more listed threatened species (other than conservation dependent species) or two or more listed threatened ecological communities.
Matter of national environmental significance	A matter defined and protected under the EPBC Act. In 2016 there were eight: • World Heritage properties • National Heritage places • wetlands of international importance (listed under the Ramsar Convention)

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines).

Reintroduction	Reestablishment of a species into its former range.
TAP	See: Threat abatement plan.
Threat abatement plan	A plan made or adopted under section 270B of the EPBC Act that establishes a national framework to guide and coordinate Australia's response to the impacts of a key threatening process.
Threatened species	A species listed under the EPBC Act as being critically endangered, endangered, vulnerable or conservation dependent.
Threatening process	A process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.
Translocation	Helping species colonise areas outside of their historical range, in this context, for conservation purposes.

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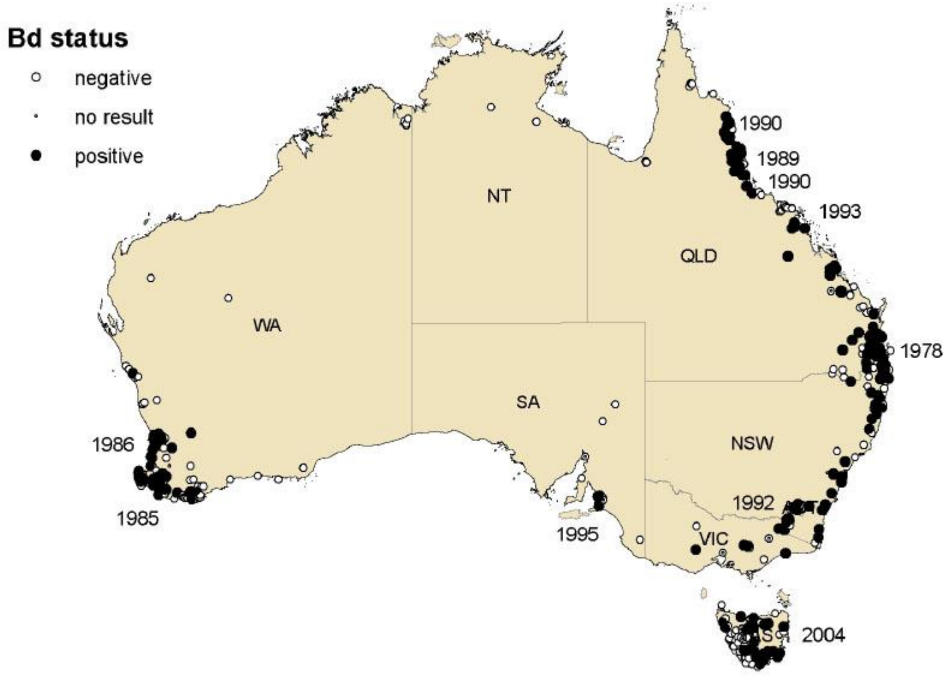
Attachment A: Map of the distribution of chytridiomycosis (with dates of first detection)



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