THREAT ABATEMENT PLAN

Infection of amphibians with chytrid fungus resulting in chytridiomycosis

Australian Government
Department of the Environment and Heritage

THREAT ABATEMENT PLAN

INFECTION OF AMPHIBIANS WITH CHYTRID FUNGUS RESULTING IN CHYTRIDIOMYCOSIS

Department of the Environment and Heritage

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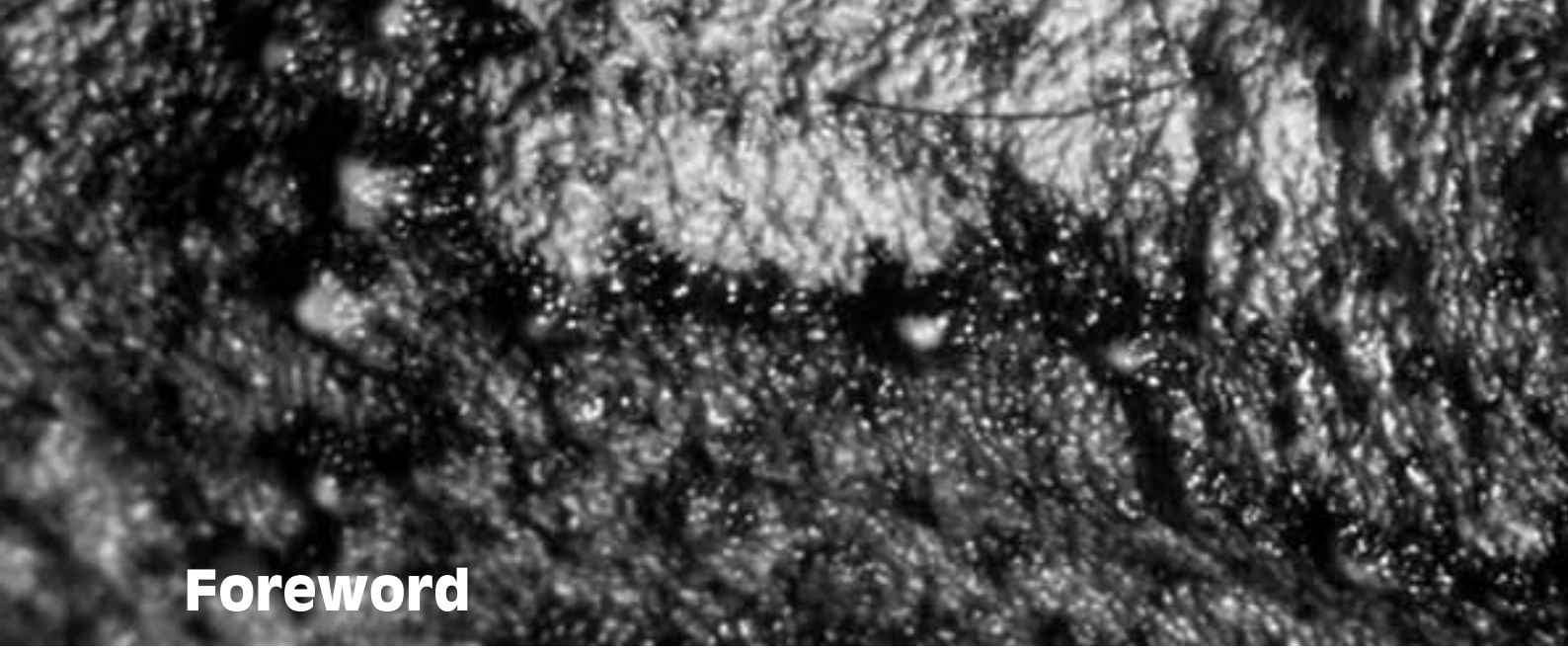
Front cover photo: *Litoria genimaculata* (Green-eyed tree frog)
Sequential page photo: *Taudactylus eungellensis* (Eungella day frog)
Banner photo on chapter pages: Close up of the skin of *Litoria genimaculata* (Green-eyed tree frog)



Foreword

'Infection of amphibians with chytrid fungus resulting in chytridiomycosis' was listed in July 2002 as a key threatening process under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

A process can be defined as a key threatening process under the EPBC Act if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

Chytridiomycosis is an infectious disease affecting amphibians worldwide. The disease has been recorded in four regions of Australia, namely the east coast, southwest Western Australia, Adelaide, and more recently Tasmania. This highly virulent fungal pathogen of amphibians is capable at the minimum of causing sporadic deaths in some populations, and 100 per cent mortality in other populations.

Threat abatement plans focus on strategic approaches to reduce the impacts of key threatening processes to maximise the chances of the long-term survival of native species and ecological communities affected by the process.

This threat abatement plan has two broad goals: to prevent amphibian populations or regions that are currently chytridiomycosis-free from becoming infected by preventing further spread of the amphibian chytrid within Australia, and to decrease the impact of infection with the amphibian chytrid fungus on populations that are currently infected.

Under the EPBC Act the Australian Government implements the plan in Commonwealth areas and seeks the cooperation of the states and territories where the disease impacts within their jurisdictions. The Australian Government also supports the national effort through financial assistance for key national level actions in the plan, such as research and demonstration model projects that can be provided to land holders and managers to assist with effective threat management.

The plan sets out an approach to achieving these goals by implementing currently available management strategies for control of chytridiomycosis, providing for the development of new techniques, and collecting information to improve our understanding of the extent of the pathogen in Australia and its effects.

David Borthwick
Secretary
Department of the Environment and Heritage

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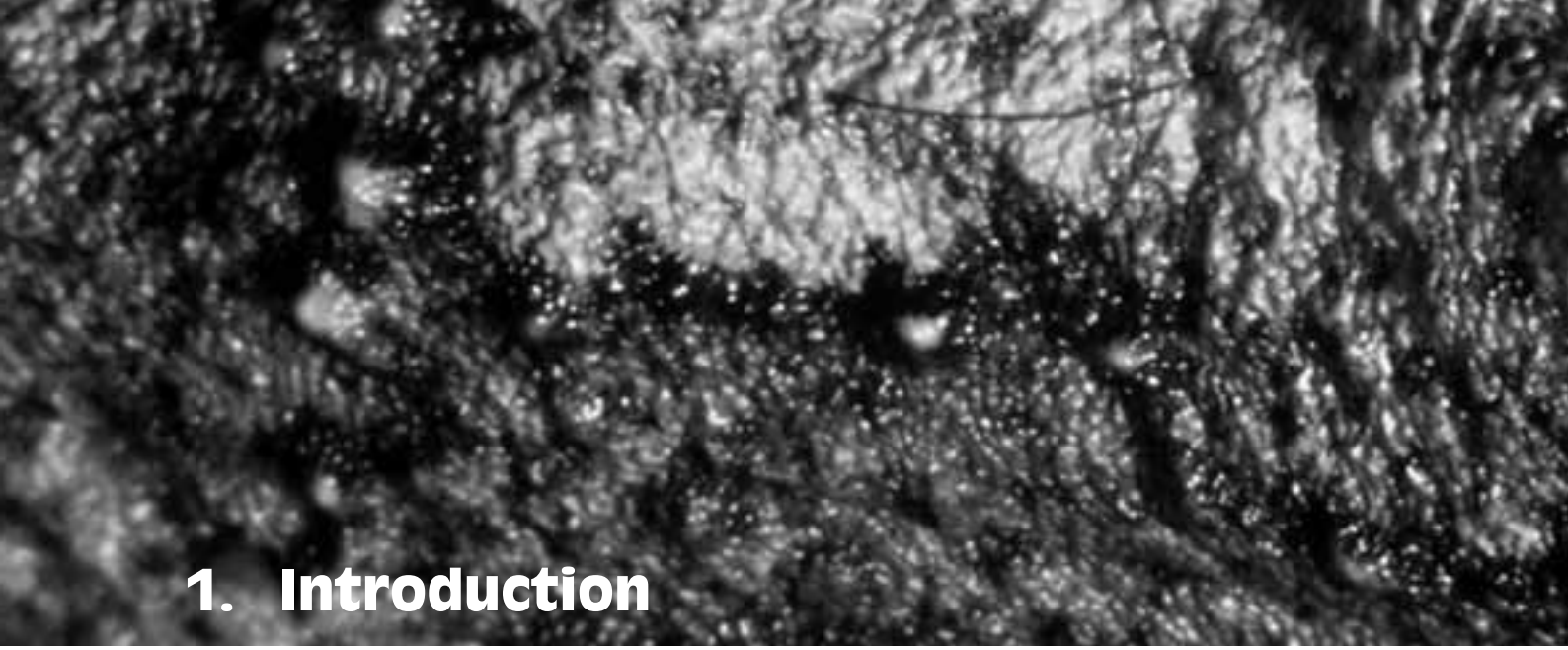


1. Introduction

Australia's native amphibians are threatened by a pathogenic fungus, *Batrachochytrium dendrobatidis*, known as amphibian chytrid fungus, which causes the infection known as chytridiomycosis. It appears that the amphibian chytrid was introduced to southeast Queensland in the mid- to late-1970s, and subsequently spread to occupy a zone in eastern Australia from Big Tableland in north Queensland to Melbourne in Victoria. Three other zones of occurrence have been identified: southwestern Western Australia, Adelaide, and more recently Tasmania.

The effects of chytridiomycosis on amphibian populations, particularly those in upland eastern Australia, have been devastating with at least one population driven to extinction, and threatened species status of others worsened. Chytridiomycosis has now been identified in 52 per cent of threatened amphibian species (Appendix A notes amphibian species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* and their status with regard to infection with the amphibian chytrid fungus). The level of the threat and its distribution could easily increase by movement of infected amphibians to chytridiomycosis-free areas and consequent escape of *B. dendrobatidis* into new wild amphibian populations. In addition, *B. dendrobatidis* can spread independently or with the assistance of amphibians.

'Infection of amphibians with chytrid fungus resulting in chytridiomycosis' is listed as a 'key threatening process' under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). At the time of listing, the Australian Government Minister for the Environment and Heritage determined that having a threat abatement plan (TAP) was a feasible, effective and efficient way to abate the infection process, and directed a nationally coordinated threat abatement plan be prepared to guide management of the impact of the amphibian chytrid fungus on Australian amphibians.

While eradication of *B. dendrobatidis* is not possible at present, well developed management plans based on current knowledge can assist in restricting the impact and spread of known infestations of the amphibian chytrid and limit spread to new sites.

This TAP aims to minimise the impact of chytridiomycosis on Australian amphibian populations. The TAP has two broad goals:

1. To prevent amphibian populations or regions that are currently chytridiomycosis-free from becoming infected by preventing further spread of the amphibian chytrid within Australia.
2. To decrease the impact of infection with the amphibian chytrid fungus on populations that are currently infected.

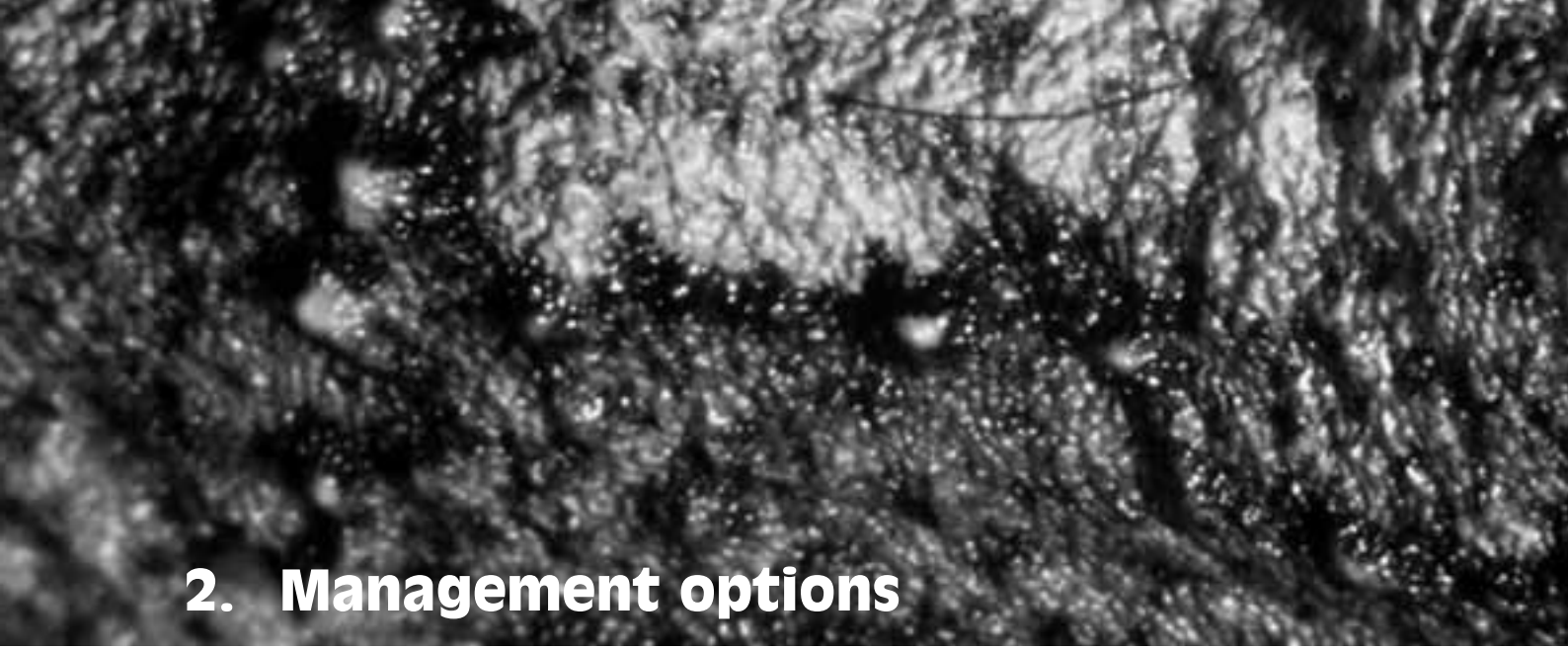
Actions will implement currently available strategies for control of chytridiomycosis, provide for the development of new techniques, conduct national surveys to improve our understanding of the extent of the pathogen in Australia and improve our understanding of the pathogen and its effects. A critical performance indicator will be the stability of currently infected amphibian populations and the continuing chytridiomycosis-free status of amphibians in non-infected regions.

In addressing the conservation of species, this TAP provides guidance to species recovery plans and existing state and territory programmes. Action will also be taken to ensure that *B. dendrobatidis* does not become established in important areas, particularly islands, that are at present free of the pathogen. In addition, there will be a focus on collecting and disseminating information to improve our understanding of control and mitigation methods and their effects on host populations, particularly in areas that are currently infected and in areas of manageable size which have been recently identified as infected.

Implementation of the plan will allow for consolidation and coordination of the process of managing the impact on native amphibian populations of infection with *B. dendrobatidis*. The main priority is to provide support for on-ground control programs that are necessary for the recovery of threatened species and threatened amphibian communities. Control programmes will have to continue for some time and the costs of this will be considerable. This plan therefore establishes a framework for allowing the best possible use of resources that are available for managing infection of amphibians with the amphibian chytrid fungus.

Detailed information supporting this plan on amphibian chytrid biology, population dynamics, spread, diagnosis, impacts on biodiversity, and management considerations and measures, are in the *Background document for the threat abatement plan — infection of amphibians with chytrid fungus resulting in chytridiomycosis*, and can be found at:

www.deh.gov.au/biodiversity/threatened/publications/tap/chytrid/



2. Management options

This TAP is the first attempt to manage chytridiomycosis at a national level using a comprehensive, integrated approach. There are no evidence based models to use as a template and since chytridiomycosis was only recognised and described in 1998, evidence on effective management strategies is limited. The management strategies proposed in this document are based on best available evidence, but for a number of aspects, evidence is missing or markedly deficient. Carrying out targeted research is an essential strategy to correct this deficiency.

The two general options in managing a pathogen are eradication (meaning 100 per cent of the pathogen is killed) and control to reduce its effect to a designated level. Eradication requires a large initial effort, but if successful, management strategies largely cease once the goal is reached. Control usually requires less commitment of resources, but is typically ongoing as the pathogen continues to interact with hosts.

2.1 Eradication

Eradication of *B. dendrobatidis* would be the ideal outcome because once this has been accomplished resources would only be required to monitor for new invasions. In order for this to be a viable option, a number of issues would need to be addressed:

- all current instances of *B. dendrobatidis* infection must be identified and mapped
- any new occurrences of *B. dendrobatidis* must be identified rapidly
- the conditions that result in pathogenicity of *B. dendrobatidis* must be identified and removed or modified
- *B. dendrobatidis* must not be able to survive in the absence of suitable amphibian hosts
- there must be no independent or human-assisted spread of the pathogen
- there must be a highly effective remediation strategy that does not impact severely on the infected amphibian population
- remediation must be carried out in all areas that are currently infected
- a discounted benefit–cost analysis must be demonstrated to favour eradication over control *and*
- there must be an appropriate legal, social and political environment.

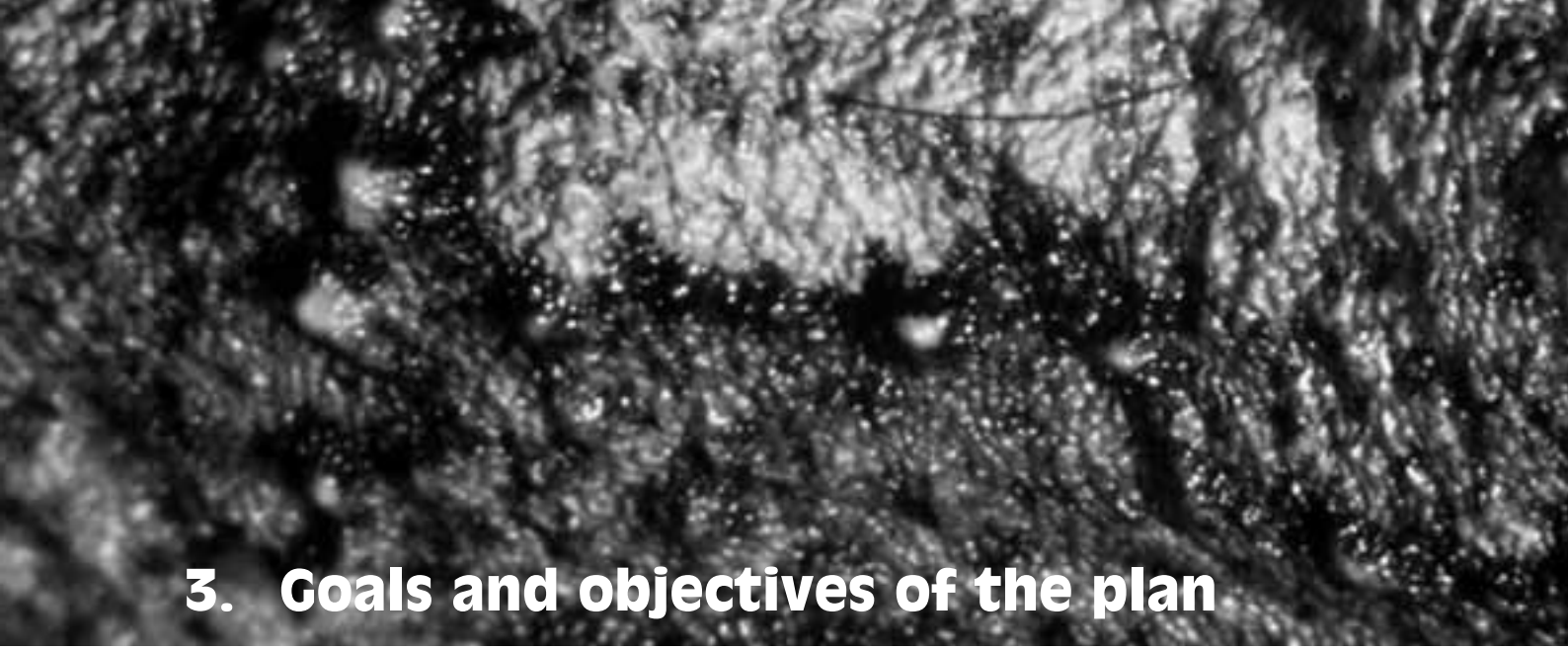
Eradication of *B. dendrobatidis* from Australia is not feasible at this time because:

- *B. dendrobatidis* appears to have an existence in the environment independent of amphibian hosts
- *B. dendrobatidis* is geographically widespread
- *B. dendrobatidis* occurs in water bodies in remote locations at which eradication strategies would be expected to be difficult to implement
- there is no effective remediation process *and*
- the severity of pathogenicity is associated with host and climatic conditions, which are aspects that are difficult to modify.

Eradication in a localised area of high conservation value that is isolated from other chytridiomycosis-positive areas is attractive in theory, but has not been tested in practice.

2.2 Control

Control rather than eradication is the only option at this time. The overall goal of control should be to prevent chytridiomycosis from causing any amphibian to become threatened or to change to a greater threatened species status. In this case, control would have two broad goals as noted in chapter three.



3. Goals and objectives of the plan

As required under the EPBC Act s271(2)(a), this TAP aims to minimise the impact of chytridiomycosis on Australian amphibian populations. The TAP has two broad goals:

1. To prevent amphibian populations or regions that are currently chytridiomycosis-free from becoming infected by preventing further spread of the amphibian chytrid within Australia *and*
2. To decrease the impact of infection with the amphibian chytrid fungus on populations that are currently infected.

The TAP's goals are to be pursued through the following five objectives:

(i) **Prevent spread:** Prevent the spread of *B. dendrobatidis* into areas where it may impact on threatened amphibian species or may lead to amphibian species becoming threatened.

(ii) **Promote recovery:** Promote the recovery of nationally listed threatened amphibian species that are known or perceived to be threatened by infection with *B. dendrobatidis*.

(iii) **Control infection:** Improve the effectiveness and efficiency of the management of infection with amphibian chytrid through appropriate research and monitoring programmes.

(iv) **Share information:** Share information with Australian, state and territory government management agencies, researchers and other academics, landholders, relevant industries and the public about the Threat abatement plan's actions and their outcomes.

(v) **Coordinate management:** Coordinate management activities effectively.

4. Actions to achieve the objectives

As required under the EPBC Act s271(2)(c) this TAP aims to minimise the impact of chytridiomycosis on Australian amphibian populations. Successful implementation of the plan will result in the stability of currently infected amphibian populations and the continuing chytridiomycosis-free status of amphibians in non-infected regions.

Prioritising actions

Any priority listing of actions can only be done with the understanding that flexibility is essential to allow priorities to be changed to reflect new developments. This TAP has 14 action groups under its five objectives. Since the development of the draft plan, a number of actions have been initiated to develop guidelines and to generate additional evidence for management decisions. Actions funded to date have been of a relatively higher priority. Each action is allocated a category based on priority and the nature of funding required for the activity. These categories are listed below:

Category 1: Actions currently funded in whole or part

Category 2: Actions most urgently requiring funding

Category 3: Actions requiring funding, but of lower priority *and*

Category 4: Actions that can be implemented without specific government funding.

4.1 Objective 1: Prevention of pathogen spread

Objective: To prevent the spread of *B. dendrobatidis* into areas where it may impact on threatened amphibian species or may lead to amphibian species becoming threatened.

Performance indicator: Appropriate quarantine and management strategies are implemented that prevent transmission of *B. dendrobatidis* from areas with chytridiomycosis to areas that are chytrid-free.

Amphibian chytrid is present in eastern Australia from Big Tableland in north Queensland to Melbourne in Victoria, as well as in southwestern Western Australia, Adelaide, and more recently Tasmania. Modelling by Rettallick, 2003 (see background document) predicted that the amphibian chytrid could infect amphibians in a zone along the whole east coast and southern coast to west of Adelaide. Retallick also modelled scenarios to see what the impact of discovering chytridiomycosis at currently chytridiomycosis-free sites would be. He found that if cases of chytridiomycosis are found in the following areas, the predicted distribution will expand significantly to the Northern Territory and Gulf Country, central Australia, and the south coast along the Great Australian Bight. These areas are therefore priority areas for well designed surveys and are included in Action 1.1.2.

Action group 1.1 — Limit national spread

Action 1.1.1: Update the status of chytridiomycosis-free states and territories, and regions within infected states and territories, after the national survey (see action 1.1.2) and on a regular basis as other reliable results become available. This information is most effectively published on the internet and the most suitable location is the Amphibian Disease Home Page:

http://www.jcu.edu.au/school/phtm/PHTM/frogs/ampdis.htm (Category 1).

Action 1.1.2: Undertake a coordinated national survey of frog populations in chytridiomycosis-free regions using standardised sampling protocols and diagnostic techniques to determine the distribution of the chytrid fungus and the affected amphibian species. The priority regions and populations for this survey are Gulf Country, Northern Territory, western Queensland, western New South Wales, northern South Australia, the coast along the Great Australian Bight, northwest Western Australia and western Victoria (Category 2).

Action 1.1.3: Prepare a model action plan (written along the lines of AusVetPlan — http://www.aahc.com.au/ausvetplan/) for chytridiomycosis — free populations based on a risk management approach, setting out the steps of a coordinated response if infection with chytridiomycosis is detected (Category 2).

The model action plan will be based on a risk management approach using quantitative risk analysis where possible and will be able to be modified to become area-specific or population-specific. The plan could be implemented in the face of new outbreaks in chytridiomycosis-free areas or in chytridiomycosis-free populations.

Individual jurisdictions can modify the model action plan as a preventative strategy or at least have it available as the framework for a response plan if needed. This will help ensure national consistency in responses to any new outbreaks. For threatened species, the action plan should inform relevant species recovery plans. Infrastructure, protocols, responsibilities and funding sources should be identified in this action plan, using the approach used in AusVetPlan.

To protect areas that are chytridiomycosis-free, an underlying principle should be that amphibians with chytridiomycosis are not transported into chytridiomycosis-free areas. Actions to reduce transmission into chytridiomycosis-free areas should aim for reduction of risk at source, and prevention of dissemination of *B. dendrobatidis* at destination.

Action 1.1.4: Using current evidence that the Northern Territory is chytridiomycosis-free, the jurisdiction should develop and implement strategies to prevent the accidental introduction of amphibian chytrid (Category 4).

Action 1.1.5: Current evidence is that Queensland, New South Wales, Victoria, Australian Capital Territory, South Australia, Tasmania and Western Australia have regions and populations of frogs infected with the amphibian chytrid. These jurisdictions should develop and implement strategies to prevent transmission to the Northern Territory and chytridiomycosis-free areas within their own and other states (Category 4).

Action group 1.2 — Reduce risk at source

Action 1.2.1: Develop and implement a minimum set of disease control standards for individuals, firms or organisations that send amphibians to others, or release amphibians to the wild, to prevent amphibian stock becoming infected with chytridiomycosis. The standards should address:

- quarantine of amphibians entering the facility;
- prevention of transmission between tanks;
- isolation and management of ill animals;
- disinfection of all water and waste prior to discharge or disposal;
- disinfection of reusable tanks and equipment;
- postmortem examination of dead amphibians;
- monitoring of stock for chytridiomycosis; and
- treatment protocol for amphibians prior to release or dispatch from the facility (Category 1).

Action 1.2.2: Establish an accreditation system for commercial facilities that sell amphibians to certify chytridiomycosis-free status after meeting criteria based on the points in Action 1.2.1 (Category 1).

Action 1.2.3: For areas with chytridiomycosis, the same protocol to manage accidentally translocated amphibians should be implemented as listed for areas that are chytridiomycosis-free (Category 2) (see Action 1.4.1).

Action 1.2.4: Assist industries that pose the greatest risk of accidental translocation of amphibians (including tadpoles) to develop protocols to prevent amphibians entering produce, nursery or other material prior to movement. Strategies used in the banana industry at Tully, Queensland could provide a good model for other industries (Category 3).

Action group 1.3 — Reduce risk at destination

Action 1.3.1: Prevent the release of amphibians taken from areas with chytridiomycosis into chytridiomycosis-free areas. Their captive-bred progeny may, however, be released into chytridiomycosis-free areas if sourced from a chytridiomycosis-free accredited facility (Category 4).

Action 1.3.2: Prevent release of amphibians derived from areas with chytridiomycosis into chytrid-contaminated areas. However, release can be permitted if these amphibians are:

- sourced from a chytridiomycosis-free accredited facility; *and*
- tested and shown to be chytridiomycosis-free prior to release (Category 4).

If tadpoles are originally sourced from the release site, release can be permitted if the amphibians have been treated prior to release with a technique with very high efficacy against chytridiomycosis and a sample has been tested and shown to be chytridiomycosis-free prior to release.

Action 1.3.3: Subject any amphibians that are accidentally translocated in agricultural produce or nursery material into chytridiomycosis-free areas to quarantine, and either painless destruction or treatment and testing for chytridiomycosis, prior to dissemination for permanent housing in collections from which the specimens cannot be released to the wild (Category 4).

Action group 1.4 — Develop, implement and promote hygiene protocols

Action 1.4.1: Use existing state protocols for quarantine and handling amphibians in chytridiomycosis-free areas as a basis to develop a national protocol (Category 1).

This could potentially be modelled on the *Hygiene Protocol for the Control of Disease in Frogs* prepared and implemented by New South Wales National Parks and Wildlife Service and informed by research results from Action 3.4.3 and experience.

Action 1.4.2: Implement field hygiene protocols that aim to prevent transmission of amphibian chytrid fungus, that are not so rigorous as to discourage or prevent research on or study of amphibian populations, and that realistically assess risks associated with all users of water catchments (Category 4).

Action 1.4.3: Ensure licences and permits for wildlife or flora studies or other activities that have the potential to transmit amphibian chytrid fungus into chytridiomycosis-free areas, include conditions that require the use of appropriate disinfection strategies between sites using techniques other than drying as listed in Table 3 of the background document (Category 4).

Action group 1.5 — Prevent release of *B. dendrobatidis* from laboratories

Action 1.5.1: Laboratories experimenting with *B. dendrobatidis* to follow PC2 (see glossary) protocols including sterilisation or disinfection of cultures, contaminated water or equipment (by one of the techniques listed in Table 3 of the background document). Drying should not be used as the sole technique (Category 4).

4.2 Objective 2: Recovery of listed threatened species

Objective: To promote the recovery of nationally listed threatened amphibian species that are known or perceived to be threatened by infection with *B. dendrobatidis*.

Performance indicator: Strategies, protocols and actions to limit the impact of infection for each species are included in recovery actions, including threatened species recovery plans.

Action group 2.1 — Manage threatened amphibians to minimise the threat from chytridiomycosis

Action 2.1.1: Coordinate captive breeding, captive husbandry and restocking programs across states and territories to maximise effectiveness of activities and knowledge in producing high quality outcomes (Category 1).

Action 2.1.2: Establish national guidelines to standardise techniques for, and approaches to, captive breeding, raising and restocking programs (Category 2).

Action 2.1.3: Expand knowledge of, and infrastructure for, captive breeding of amphibians, particularly with respect to species that are threatened or particularly vulnerable to chytridiomycosis (Category 2).

Action 2.1.4: Monitor threatened species of amphibians to determine changes in distribution and abundance, prevalence and deaths due to chytridiomycosis (Category 2).

Action 2.1.5: Use cryopreservation for Australian amphibian species, with priority on threatened species, in such a manner as to allow cloning in the future or have gametes preserved to allow artificial breeding (Category 2).

Action 2.1.6: Restock species that are under severe threat from infection with chytridiomycosis using captive-raised and captive-bred stock. Implement this under an adaptive management framework that heeds relevant state, national and international (IUCN) standards on translocations and monitor the outcome (Category 3).

Action 2.1.7: Include strategies to limit the impact of infection with the amphibian chytrid in infected species as a component of threatened species recovery plans and relevant regional and local management plans (Category 4).

Action 2.1.8: Monitor species that are currently chytridiomycosis-free (and are shown to be resistant to chytridiomycosis by the standard laboratory experimental model in Action 3.3.3) at a lower level than species that are susceptible (Category 4).

Action 2.1.9: Apply more stringent quarantine and hygiene protocols, than those specified in Actions 1.4.2, 1.4.3 and 1.5.1 to populations of amphibians that are identified as being particularly vulnerable to extinction (Category 4).

4.3 Objective 3: Research and monitoring

Objective: To improve the effectiveness and efficiency of the management of infection with amphibian chytrid through appropriate research and monitoring programmes.

Performance indicators: Standardised diagnostic tools are used to inform an understanding of the national distribution and prevalence of the disease. 2. Management strategies are informed of emerging information provided through research.

The amphibian chytrid was first identified in 1998. While significant progress has been made in understanding the disease, its biology in the environment is virtually unknown. This is a major obstacle to developing evidence-based control measures. Control strategies can be proposed with our current knowledge, but the poor understanding of how *B. dendrobatidis* behaves in the environment needs to be remedied. Ensuring that field experience and research are used to further improve management programs is an important element of this plan. Adaptive management approaches, which experimentally test existing and new management techniques, will be encouraged. By measuring the effectiveness of different management techniques in achieving the recovery of threatened species, we will improve our ability to combat the threat posed by infection with the amphibian chytrid.

Action group 3.1 — Develop diagnostic tools

Action 3.1.1: Trial the real-time PCR test for chytridiomycosis in a field situation and compare for sensitivity against the histological examination of toe clips (Category 1).

Action 3.1.2: Evaluate pooling samples as a cost effective technique for surveying large numbers of animals using the real-time PCR test, with subsequent testing of individual samples in positive pools (Category 1).

Action 3.1.3: Determine the sensitivity of using tadpoles for surveying for chytridiomycosis and compare with surveys using adults and juveniles in the same population (Category 1).

Action 3.1.4: Develop an effective tool for studying *B. dendrobatidis* in the environment to improve the understanding of the biology and occurrence of the amphibian chytrid in the environment. The most promising is the real-time PCR test currently being developed by AAHL (Category 1).

Action 3.1.5: Develop criteria for a wide-scale survey protocol applicable at the national level and carry out a survey in chytridiomycosis-free and chytrid-contaminated areas (Category 1).

Action 3.1.6: Develop a rapid in-field test to detect chytridiomycosis in amphibians at a high specificity and sensitivity for use in surveys to determine distribution of chytridiomycosis (Category 3).

Action 3.1.7: Establish a national quality accredited laboratory dedicated to the diagnosis of chytridiomycosis to facilitate the rapid detection of *B. dendrobatidis* using PCR (Category 4).

Action group 3.2 — Research epidemiology, transmission and dispersal

Action 3.2.1: Undertake research to answer questions about B. dendrobatidis in the environment with priority on the questions below (Category 1):

- Does *B. dendrobatidis* exist as a free-living organism in suitable habitats, particularly natural water bodies and moist substrate?
- Can detection of *B. dendrobatidis* be used as a technique to map contaminated and chytridiomycosis-free areas?
- How do environmental characteristics of natural water bodies (pH, pO_2, ion content, nitrate, organic content) and weather (temperature, rainfall) affect the biology and survival of *B. dendrobatidis*?
- What density of zoospores in natural water bodies can infect susceptible species of amphibians?

- Does the density of zoospores in natural water bodies correlate with intensity of infection of amphibian populations living in those water bodies, and with the level of clinical chytridiomycosis? Can the density of zoospores in natural water bodies be used to predict periods of high risk for amphibian populations?
- How does *B. dendrobatidis* spread between water bodies?
- Are there non-amphibian vectors of *B. dendrobatidis*?
- Can *B. dendrobatidis* be eradicated from ponds or small standing water bodies?

Action 3.2.2: Develop and implement effective strategies to reduce the accidental translocation of amphibians with agricultural produce and nursery materials. Surveys should be performed, particularly in chytridiomycosis-free areas, to identify the number and origin of translocated amphibians detected at markets, wholesalers and nurseries and the prevalence of chytridiomycosis in these amphibians (Category 3).

Action 3.2.3: Evaluate, through field surveys and *ex situ* experimentation, the likelihood of cane toads introducing chytridiomycosis into chytridiomycosis-free areas, particularly in areas of Northern Territory, Western Australia and Tasmania (Category 3).

Action group 3.3 — Research pathogenesis

Action 3.3.1: Determine the pathogenesis of chytridiomycosis including the host and environmental factors that determine the ultimate outcome of infection, i.e. death, persistent infection with no obvious effect, and cure (Category 1).

Action 3.3.2: Investigate surviving robust populations of species that have undergone widespread decline and determine whether management interventions can reproduce the factors that maintain these populations (Category 1).

Action 3.3.3: Determine the susceptibility and resistance of key amphibian species to chytridiomycosis using a standard laboratory model that relates to risk in the wild, particularly for species that are currently chytridiomycosis-free (Category 1).

Action 3.3.4: Perform research for evidence of resistance (and techniques to increase resistance) in at-risk species, including captive breeding and selection for restocking (Category 1).

Action 3.3.5: Assess the effect of management activities, designed to improve environmental suitability or general amphibian well-being, on the morbidity and mortality due to chytridiomycosis in chronically infected amphibian populations (Category 2).

Action group 3.4 — Assess effectiveness of management strategies

Action 3.4.1: Evaluate the effectiveness of various hygiene protocol options, using sensitive tools able to detect viable *B. dendrobatidis* in environmental samples, to inform hygiene protocols in the field that allow research and other activities at an acceptable level of feasibility (Category 1).

Action 3.4.2: Perform studies to determine whether populations that have recovered after chytrid-associated decline are susceptible to future severe effects from chytridiomycosis (Category 1).

Action 3.4.3: Assess the value of reintroduction programs for threatened species over significant periods of time, in terms of increased abundance and expansion of range of amphibians, mortality and prevalence of chytridiomycosis (Category 2).

Action 3.4.4: Develop effective and safe treatment protocols that are suitable for all Australian species of amphibians (Category 2).

Action 3.4.5: Use specimens from archived frogs to perform historical surveys where knowledge of the relationship of the arrival of the amphibian chytrid fungus to declines in the species would assist in risk assessment and preparation of frog recovery plans (Category 3).

4.4 Objective 4: Stakeholder communication on TAP objectives

Objective: To share information with Australian, state and territory government management agencies, researchers and other academics, landholders, relevant industries and the public about the Threat Abatement Plan's actions and their outcomes.

Performance indicator: Stakeholders apply best management practice to implement the plan, based upon access to, and awareness of, existing and new information and data.

Action group 4.1 — Establish communication pathways and share information

Action 4.1.1: Inform the community about basic disease management for chytridiomycosis and the risks of transporting potentially infected amphibians, water and other transmitting agents, as they are identified (Category 2).

Action 4.1.2: Educate the community to ensure support for, and compliance with, existing legislation and regulations, targeting groups at higher risk of spreading the fungus e.g. pet trade, researchers, schools, wildlife carers, as well as campers, bushwalkers, the tourist industry, and other recreational users in contact with fresh water (Category 2).

Action 4.1.3: Use proactive strategies to inform and motivate key groups within the community, in particular members of frog naturalists groups, wildlife carers and veterinarians (Category 2).

Action 4.1.4: Identify or establish an objective, credible source which can disseminate information to stakeholders, including detection of outbreaks, and can assist in the coordination of responses to outbreaks particularly in chytridiomycosis-free areas (Category 2).

Action 4.1.5: The organisation identified in Action 4.1.4 to collate, analyse, interpret and disseminate data on chytridiomycosis occurrence and prevalence to wildlife managers, researchers and the public (Category 2).

Action 4.1.6: Encourage coordination of research on infection with the amphibian chytrid, chytridiomycosis and its control. Make available an online database, at the Amphibian Diseases Home Page, of past and current research projects and contacts for researchers (Category 2).

Action 4.1.7: Publish the list of research priorities listed under Objective 3 online at the Amphibian Diseases Home Page (Category 4).

Action 4.1.8: Encourage collaborative research on chytridiomycosis and its impact on amphibian populations across disciplines and institutions, including joint supervision of research students across disciplines and institutions (Category 4).

Action 4.1.9: Establish a national database of names, locations, activities and contact details of organisations and individuals breeding and carrying out captive husbandry of native Australian frogs and made publicly available on the internet (Category 4).

Action 4.1.10: Place signage at entrances to national parks, forestry reserves, and other areas containing water bodies controlled by state and territory departments that have had cases of chytridiomycosis, to inform the public that the water catchment is chytrid positive and giving details on simple strategies to be followed to reduce the likelihood of the amphibian chytrid being taken from the site (Category 4).

4.5 Objective 5: Coordination of management activities

Objective: To coordinate management activities effectively.

Performance indicator: Stakeholders are engaged in implementation of the plan, with actions reflected in recovery plans, and local and regional management plans.

States and territories, wildlife managers, researchers, industry bodies and community members should form a partnership to decrease risks of chytridiomycosis to amphibians.

Action group 5.1 — Use frog recovery plans

Action 5.1.1: Ensure strategies to manage chytridiomycosis are addressed in frog recovery plans and include: assessing species vulnerability to chytridiomycosis; monitoring and detection of chytridiomycosis; and identifying actions to address the arrival of the amphibian chytrid in the case of chytridiomycosis-free populations or population decline for chytridiomycosis-positive populations (Category 4).

Action group 5.2 — Use regional management plans

Regional management plans, agreed by governments and the community, set out the means for identifying and achieving a region's natural resource management targets. They detail catchment-wide activities including land and water management, biodiversity and agricultural practices.

Action 5.2.1: Include a strategic overview of the threat posed by chytridiomycosis to threatened species and amphibian communities that have high conservation value in regional management plans (Category 4).

Action 5.2.2: Identify current and proposed local management plans, which address the control and/or prevention of spread of *B. dendrobatidis* for regions, in regional management plans (Category 4).

Action 5.2.3: Identify in regional management plans how local management plans will address Objectives 1, 2, 3 and 4 (Category 4).

Action 5.2.4: Regional management plans to include guidance for integration of chytridiomycosis planning into existing regional and local land and biodiversity management plans (Category 4).

Action 5.2.5: Identify in regional management plans, areas that were part of the former range of threatened species for potential later re-introduction (Category 4).

Action 5.2.6: Support regional organisations, community and industry groups and land management agencies in collaboratively developing and implementing regional management plans (Category 4).

Action 5.2.7: Where possible, management on public and private lands is integrated with other regional biodiversity conservation measures through the development of regional partnerships or ulitisation of appropriate existing structures (Category 4).

Action 5.2.8: Develop model prototype regional management plans for chytridiomycosis-free and chytrid-contaminated areas (Category 4).

Action group 5.3 — Undertake national coordination

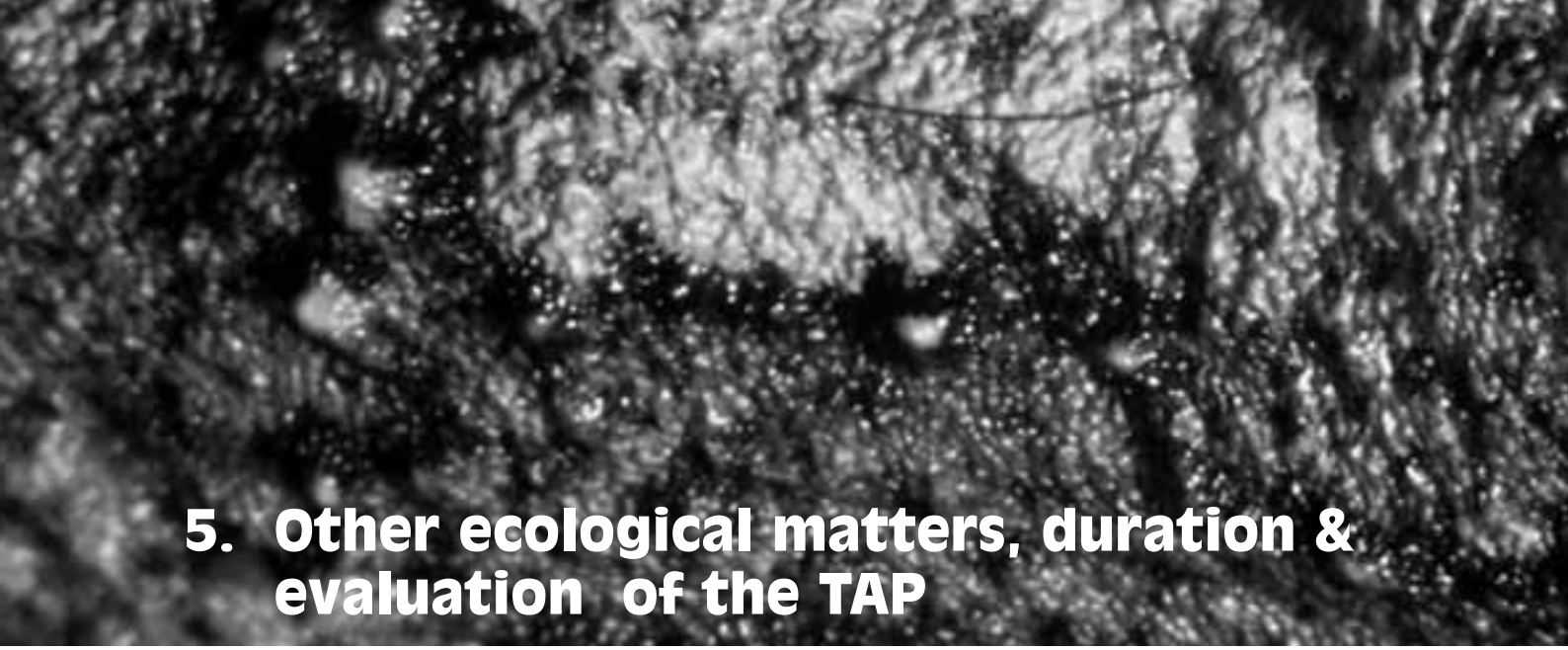
The DEH will provide support to the Amphibian Diseases Threat Abatement Committee (the Committee) to assist and monitor implementation of the plan, including reviewing the actions and broad priorities for funding, and highlighting gaps. The development of education and extension material would be assisted by the involvement of the Committee, which could also assess the potential for broader application of management methods or approaches developed through local management plans.

Action 5.3.1: Convene an Amphibian Diseases Threat Abatement Committee that includes people with technical and practical experience in chytridiomycosis and amphibian management and research, to assist implementing this plan (Category 1).

Action 5.3.2: The Committee to ensure each action is costed, its duration estimated, and given a ranking in terms of priority for implementation and lead organisation and person(s) responsible for the Action identified (Category 2).

Action 5.3.3: Revise relevant sections of the *The National Action Plan for Australian Frogs* to include an evaluation of the current status of the knowledge of the ecology of all Australian amphibian species and to recommend appropriate management actions to prevent infection with the amphibian chytrid resulting in chytridiomycosis or to decrease its impact (Category 3).

Action 5.3.4: The Committee to establish clear links with state-based Chytridiomycosis Threat Abatement Teams (or their equivalent), and with relevant regional and local bodies that are responsible for management of infection with the amphibian chytrid, to ensure that clear lines of communication are established that promote and manage best practice in on-ground actions (Category 4).



5. Other ecological matters, duration & evaluation of the TAP

5.1 Other major ecological matters affected by the TAP

Implementation of this plan is unlikely to affect other ecological matters, but implementation of all proposed actions will have regard to their broader ecological impacts.

5.2 Duration and cost of the TAP

The initial duration of the plan is five years, but the threat abatement process is likely to be ongoing, as there is no likelihood of nationally eradicating chytrid fungus in the foreseeable future.

The costs of many of the actions will be determined by the level of resources that stakeholders commit to control of the disease. The total cost of the plan's implementation over its lifetime therefore cannot be quantified at the time of making this plan.

The making of this plan does not necessarily indicate the commitment of individual stakeholders to undertaking any specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints. Due to changes in knowledge, proposed actions may be subject to modification over the life of the plan.

Australian Government funds may be available for the implementation of key national environmental priorities, such as relevant actions listed in this plan, and also on-ground implementation of actions identified in regional natural resource management plans.

5.3 Evaluating the performance of the TAP

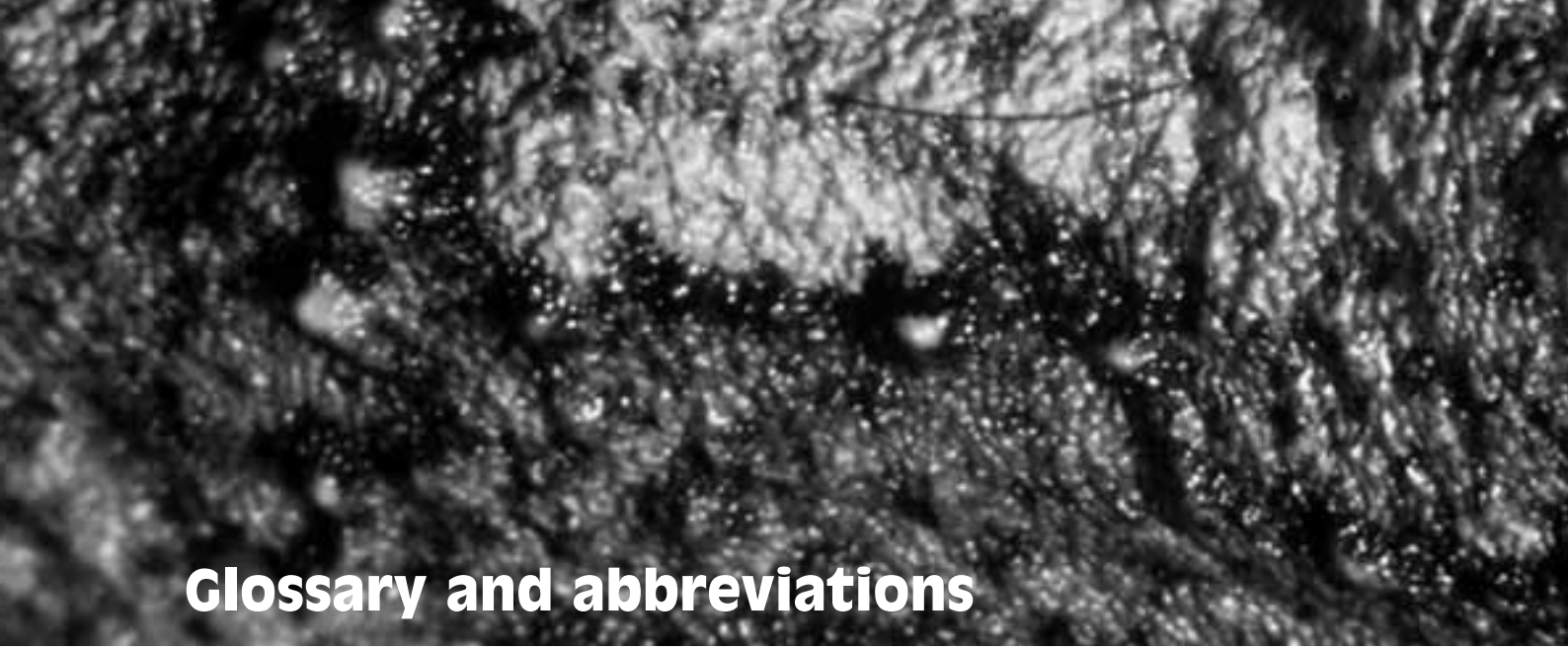
Section s271(2)(e) of the EPBC Act provides for the plan's review at any time and requires that the plan be reviewed at intervals of no longer than five years. If evidence is found that the practices recommended in the plan need to be updated or modified to prevent species becoming endangered or extinct, the Department of the Environment and Heritage (the Department) will recommend to the Minister that the plan be revised sooner.

Before the end of the five-year period, the Department will commission an independent person to review the plan's implementation, its effectiveness in abating the threat, and available technical information. The review will involve key stakeholders.

Recommendations from the review will be used to revise the plan for the next five-year phase.

The Department will facilitate implementation of the plan, encouraging involvement of key stakeholders and expertise. The Australian Government will implement the plan as it applies to Commonwealth land and act in accordance with the provisions of the plan.

The Department has convened an Amphibian Diseases Threat Abatement Committee to assist and advise on the implementation of the plan (see actions under Objective 5). The committee will include people with relevant and technical expertise in chytrid fungus management and research. It will also include stakeholders such as state and territory agencies and non-government organisations.



Glossary and abbreviations

Chytridiomycosis

The state of being infected with *B. 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).

DEH

Department of the Environment and Heritage

Epidemiology

The study of disease in populations.

Host specificity

The degree to which an infectious agent remains confined to one species of host or taxonomically related hosts. Low host specificity means that the infectious agent can infect many species of host, or species of host that are not closely related taxonomically.

PC2

Physical Containment level 2 describes the minimum standard for construction and the general responsibilities and guidelines for safety in laboratories where micro-organisms are handled. The standard is defined in the Australian Standard AS/NZS 2243.3:2002 — Safety in Laboratories Part 3: Microbiological Aspects and Containment Facilities

PCR

Polymerase Chain Reaction: a diagnostic test using a molecular biological technique to manufacture additional DNA strands from small numbers of DNA strands in the original specimen

Prevalence

The percent of the population with the disease or condition of interest at a particular point in time

Real-time PCR

A PCR test that is able to quantify the amount of DNA present in the original sample

Sensitivity

The probability of testing positive if chytridiomycosis is present

TAP

Threat Abatement Plan

Appendix A: Threatened amphibian species chytrid disease status

Table A.1. Species of threatened amphibians and their *B. dendrobatidis* infection status. Status from the Department of the Environment and Heritage (2003) web site (www.deh.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=fauna).

Scientific name	Status with respect to infection with *B. dendrobatidis*	Reference (full reference in background document)
ENDANGERED SPECIES		
Geocrinia alba White-bellied frog	No records. In chytridiomycosis-positive zone.	Aplin and Kirkpatrick (2000)
Litoria castanea Yellow-spotted tree frog	No reports. Apparently no survey performed for chytridiomycosis.sappeared in NSW about mid-1970s.	Mahoney (1999)
Litoria lorica Armoured mistfrog	No reports. No survey performed. Population declined in north Qld in 1991 when epidemic chytridiomycosis occurred.	McDonald and Alford (1999)
Litoria nannotis Waterfall frog	Upland populations disappeared in Qld with epidemic chytridiomycosis. Lowland populations have endemic chytridiomycosis.	Berger et al. (1998); McDonald et al. (2004)
Litoria nyakalensis Mountain mistfrog	No records. Upland populations disappeared in North Qld at same time as other frogs with epidemic chytridiomycosis.	McDonald and Alford (1999)
Litoria rheocola Common mistfrog	Upland populations disappeared in Qld with epidemic chytridiomycosis. Lowland populations have endemic chytridiomycosis.	Berger et al (1998); McDonald et al. (2004)
Litoria spenceri Spotted treefrog	Upland populations declined steadily over 20th century, but a precipitous decline of a population at Bogong Ck, Kosciuszko in 1996 was associated with chytridiomycosis. Victorian populations have endemic chytridiomycosis.	Berger et al. (1998); Gillespie and Hines (1999)
Mixophyes fleayi Fleay's frog	*B. dendrobatidis* endemic in SEQ and northern NSW populations.	Mahoney (2000); Speare and Berger (2003); Symmonds et al. (2003).
Mixophyes iteratus Southern barred frog	*B. dendrobatidis* is endemic in eastern NSW populations.	Mahoney (2000)
Nyctimystes dayi Lace-eyed tree frog	Upland populations disappeared in Qld with epidemic chytridiomycosis. Lowland populations have endemic chytridiomycosis.	Berger et al. (1998); McDonald and Alford (1999); McDonald et al. (in prep)
Philoria frosti Baw Baw frog	No reports. Survey of archived and extant specimens being planned.	Osborne et al. (1999)
Pseudophryne corroboree Southern corroboree frog	*B. dendrobatidis* endemic since 1991 and possibly major cause of population decline.	Speare and Berger (2003)
Spicospina flammocaerulea Sunset frog	No reports. Apparently no survey performed.	
Taudactylus eungellensis Eundella day frog	*B. dendrobatidis* detected as after declines; now endemic.	Speare and Berger (2003); Marshall (1998); Rettalick et al. (2004)
Taudactylus rheophilus Tinkling frog	No reports. Apparently only one specimen examined. Populations declined in 1989. In area endemic for *B. dendrobatidis*.	McDonald and Alford (1999); Rettalick et al. (2004)

VULNERABLE SPECIES		
Geocrinia vitellina Orange-bellied frog	*B. dendrobatidis* detected in survey of archived specimens.	Aplin and Kirkpatrick (2000)
Heelioporus australiacus Giant burrowing frog	*B. dendrobatidis* detected in survey of archived specimens.	Speare and Berger (2003)
Litoria aurea Green and gold bell frog	*B. dendrobatidis* endemic in NSW populations.	Mahony (2000); Speare and Berger (2003)
Litoria littejohni Littlejohn's tree frog	No reports. Apparently no survey performed.	
Litoria olongburensis Wallum sedge frog	No records. Apparently no survey for chytridiomycosis performed. Mainland sites endemic for *B. dendrobatidis*, but no positive records from limited surveys of Stradbroke Island. Nature of decline unclear. This species listed because of loss of habitat	Hines et al. (1999)
Litoria piperata Peppered tree frog	No records. Apparently no survey performed. Occurs in region with endemic *B. dendrobatidis.*	Gillespie and Hines (1999)
Litoria raniformis Southern bell frog	*B. dendrobatidis* endemic in populations in Adelaide and environs.	Speare and Berger (2003)
Litoria verreauxii alpina Alpine tree frog	No records. Apparently no survey performed. In area endemic for *B. dendrobatidis*.	Gillespie and Marantelli (2000)
Mixophyes balbus Southern barred frog	*B. dendrobatidis* endemic in populations in NSW.	Mahony (2000)
Pseudophryne covachevicae Magnificient brood frog	No records. No survey done.	
Pseudophryne pengilleyi Northern corroboree frog	*B. dendrobatidis* endemic since at least 1991.	Speare and Berger (2003)
Taudactylus pleione Kroombit tinker frog	No reports. No specimens examined. *B. dendrobatidis* endemic in region.	

Table A.2. Threatened species declared extinct in 2000 and relationship to the key threatening process of infection with B. dendrobatidis (DEH 2003).

Scientific name	Status re Infection with *B. dendrobatidis*	Reference
Rheobatrachus silus Southern gastric brooding frog	Pattern of decline consistent with epidemic chytridiomycosis. Chytridiomycosis not found in very small histological survey of toes of 4 museum specimens collected pre-decline.	Laurance et al (1996); Berger et al (1998)
Rheobatrachus vitellinus Northern gastric brooding frog	Pattern of decline consistent with epidemic chytridiomycosis. No survey of archived specimens.	Laurance et al (1996); Berger et al (1998)
Taudactylus acutirostris Sharp-snouted day frog	Last population at Big Tableland made extinct by epidemic chytridiomycosis that began in 1993.	Berger et al (1998); Berger et al (1999)
Taudactylus diurnus Southern day frog	Pattern of decline consistent with epidemic chytridiomycosis. Chytridiomycosis not found in survey (using direct smear of superficial epidermis) of 25 museum specimens collected pre-decline.	Laurance et al (1996); Berger et al (1998)

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Australian Government

Department of the Environment and Heritage