Recovery plan for stream frogs of south-east Queensland 2001-2005

Prepared by Harry Hines, Queensland Parks and Wildlife Service, and the South-east Queensland Threatened Frogs Recovery Team

Fleay's barred-frog *Mixophyes fleayi* (photo by Harry Hines QPWS)

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Publication reference:
Hines, H. B. and the South-east Queensland Threatened Frogs Recovery Team. 2002. Recovery plan for stream frogs of south-east Queensland 2001-2005. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.

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Contents

Summary

This document is a five-year multi-species plan for the recovery of seven threatened stream frogs of south-east Queensland. The southern dayfrog and southern gastric-brooding frog declined and disappeared in the late 1970s to early 1980s. They have not been located since then, despite considerable survey effort. All other species are reported to have undergone population declines, although these are sometimes poorly quantified. One of these species, the cascade treefrog, declined markedly in Queensland in the late 1970s early 1980s. However, numbers have since shown some recovery.

As the causes of the declines and disappearances are unknown, ongoing monitoring of key sites and investigations into the causes of declines are essential actions in the plan. These activities are central to the development of effective threat abatement measures and ultimately species recovery.

This recovery plan details the decline, possible threats, and current and proposed monitoring, research and management actions required for recovery of these species. The estimated total cost of implementing this plan is $1.3 million and involves the co-operative efforts of community groups, researchers, land managers and funding agencies.

Habitat requirements and limiting factors

The seven species considered in this plan are stream-associated forest-dependent frogs of the eastern escarpment. They are generally found in moister forest types (rainforest and wet sclerophyll) over a wide range of elevations, but most often occur in the ranges and foothills. They breed in a range of stream environments.

The major threatening processes have not yet been identified, despite documentation of population declines. Investigation of disease as a threatening process is one of the objectives of this recovery plan.

Overall objective

To significantly improve the conservation status and long term survival of each species through protection of its habitat, and through location of additional populations or expansion of existing populations into areas currently uninhabited.

Specific objectives (2001-2005)

1. To down list the cascade treefrog from endangered to vulnerable within five years based on IUCN (2001) criteria of population size and trends, extent of occurrence and probability of extinction.
2. To determine whether the southern gastric-brooding frog and the southern dayfrog are extant.
3. To secure existing populations of extant species.
4. To investigate disease as a key threatening process.
5. To increase the number of populations of extant species by facilitating expansion into their former range.

Nineteen performance criteria will be used to assess the success of the recovery program. The recovery team and two independent reviewers will review this recovery plan at the end of the third year.

Actions

1. Manage the recovery process.
2. Monitor populations.
3. Gain information required for management.
4. Protect populations and manage habitat.
5. Provide education and information.

Introduction

This recovery plan has been developed from the draft recovery plan for the southern gastric-brooding frog and southern dayfrog (Martin *et al.* 1997), a draft national recovery plan for barred-frogs and the cascade treefrog (QPWS 2000), and the draft recovery plan for the Kroombit tinkerfrog (Borsboom *et al.* 1999). The earlier plans have been partially implemented. This recovery plan has been prepared for adoption under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. It provides an overview of the decline of seven stream-dwelling frog species of south-eastern Queensland and actions needed to recover these species.

Location and species

This plan includes seven species of threatened stream frogs from south-east Queensland (Table 1).

Table 1. *Current status of species considered in this recovery plan.*

Common name	**Scientific name**	**EPBC Act 1999**[1]	**Action Plan 1997**[2]	**Qld NC(W) Reg 1994**[3]	**IUCN**[4]
Fleay's barred-frog	*Mixophyes fleayi*	EN	EN	EN	EN [B2ab(iii)]
Giant barred-frog	*Mixophyes iteratus*	EN	EN	EN	EN [B2ab(iii)]
Southern gastric-brooding frog	*Rheobatrachus silus*	EX	EN	EN	EX
Southern dayfrog	*Taudactylus diurnus*	EX	EN	EN	EX
Kroombit tinkerfrog	*Taudactylus pleione*	VU	VU	VU	CR [B1ab(iii,v)+2ab(iii,v)]
Cascade treefrog	*Litoria pearsoniana*	NL	IK	EN	LC
New England treefrog	*Litoria subglandulosa*[5]	NL	IK	VU	NT

Codes used (as defined in the relevant legislation/document); EX = presumed extinct, CR = critically endangered, EN = endangered, VU = vulnerable, IK = insufficiently known species that may be of concern, NT = near threatened, LC = least concern, NL = not listed as threatened.
Source: (as at April 2001)
1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
2 Tyler 1997.
3 Queensland *Nature Conservation (Wildlife) Regulation 1994.*
4 IUCN Red List Category (2001), as determined at the IUCN workshop held in Hobart 2001. Criteria are shown in square brackets.
5 *Litoria subglandulosa sensu lato* - see appendix for details.

In Queensland the distribution of these frogs lies within the region extending south along the foothills and ranges of the Great Divide from about Gladstone to the New South Wales border. The area is fully encompassed by the Southeast Queensland and New England Tableland Bioregions (Stanton and Morgan 1977). Three of the species are restricted to the former. The other four species also occur farther south in New South Wales.

A species profile for each frog, which includes a description of distribution, habitat, biology and threats, is provided as an Appendix. This recovery plan is concerned only with actions necessary for the recovery of populations of the seven threatened

frogs in south-east Queensland. The New South Wales National Parks and Wildlife Service are preparing recovery plans for New South Wales populations.

Declines, disappearances and possible causes

Declines of frogs from rainforest streams in south-east Queensland were first noticed in the late 1970s. By the early 1980s, the southern dayfrog and southern gastric-brooding frog had disappeared and at least three other species had declined - Fleay's barred-frog, giant barred-frog and cascade treefrog.

Similar declines and disappearances subsequently occurred along streams in other rainforest areas. On the Eungella Plateau in mid-east Queensland, the northern gastric-brooding frog *Rheobatrachus vitellinus* was last seen in the wild in 1985, and other species declined at the same time. During the early 1990s, seven frog species endemic to the Wet Tropics declined or disappeared - three remain missing.

Since then, declines of two other stream frogs from south-east Queensland have been detected. The New England treefrog was only known in Queensland from two sites in Girraween National Park. It has disappeared from one of those sites, but has been located at a few new sites. The Kroombit tinkerfrog was discovered in 1983 and occurs in a dozen small pockets of rainforest at Kroombit Tops. In the late 1990s, the only intensively monitored population declined dramatically. Its population is now estimated to consist of hundreds of individuals.

Catastrophic declines have also been documented from overseas rainforests, for example in Costa Rica and Panama. Campbell (1999) has reviewed the declines and disappearances of Australian frogs. The causes of the declines and disappearances are unknown, although several hypotheses have been proposed. It is not known whether the declines were caused by the same factor(s) in different species and in different regions. However, the patterns of decline are similar. The declines were rapid; the species that suffered were dependent upon streams in wet forests (principally rainforest); and species that bred away from streams were not affected.

The identification of the major threatening processes affecting stream frogs in south-east Queensland is an objective of the recovery plan. Recent studies of amphibian disease have identified a chytrid fungus as a cause of frog mortality and as the cause of death of frogs collected during declines (Berger *et al.* 1998, Berger *et al.* 1999). The investigation of the role played by chytrid fungus during frog declines is now a major focus of the amphibian disease project. This recovery program and others in Australia and overseas have strong links with the frog disease project. The chytrid fungus has been widely recorded in south-east Queensland from a range of frog species.

Other theories of causal agents have been postulated, for example increased UV-B radiation, chemical pollutants, climate change, or some synergistic or cumulative effect of multiple agents. However, at present there are no well developed hypotheses relating these possible causes to frog declines in south-east Queensland. If necessary, the recovery plan will be modified to include investigations of other threatening processes.

Although considerable work is required investigate and manage the regional declines of stream dwelling frogs, local threats to their habitat and remaining populations also need to be addressed. These threats arise from clearing, introduced fish, mammals and weeds, forestry activities, agriculture, mining, tourism, domestic stock and

hydrological changes (Parris and Norton 1997, Gillespie and Hines 1999, Gillespie and Hero 1999; Hines *et al.*1999). Protection of the habitat and remnant populations of threatened stream frogs is another objective of this plan.

Habitat critical to survival

This plan does not cover the full range of four species, Fleay's barred-frog *Mixophyes fleayi*, Giant barred-frog *Mixophyes iterates*, Cascade treefrog *Litoria pearsoniana* and New England treefrog *Litoria subglandulosa*. These species also occurs in NSW. The habitat critical to the survival of the species described in this plan is critical habitat occurring within the region covered by this plan. It should be noted that additional critical habitat for this species may occur in other parts of its range.

Habitat critical to the survival of the species considered in the plan is described in Table 2. For most species, critical habitat has been defined in terms of stream environments. All but two species are obligate stream breeders, that is, frogs with tadpoles that develop in streams. The southern gastric-brooding frog is almost entirely aquatic and is never seen more than a few metres from streams. Its tadpoles develop within the stomach of the female. The breeding biology of the Kroombit tinkerfrog is not known, but calling males are only found in rainforest and are almost always associated with watercourses or seepage areas.

For the purpose of describing critical habitat, a stream is defined as a 40m corridor centred on the middle of the stream bed. While this definition may help protect the stream and its immediate surrounds, it is likely to be inadequate for protecting water quality, hydrological processes and non-breeding habitat of the frogs. Quantitative information on non-breeding habitat usage is scant. Some species have never been recorded far from streams but others, such as females of Fleay's barred-frog, have been observed many hundreds of metres from breeding sites. Therefore the definition of critical habitat may be broadened in future revisions of the plan when there is better knowledge of non-breeding habitat requirements.

Table 2. *Critical habitat for frogs stream frogs of south-east Queensland.*

Common name	**Habitat critical for breeding**
Fleay's barred-frog	Permanent and semi-permanent freshwater streams, between 100-1000m in altitude, in rainforest and other forest communities of the McPherson, Main and Conondale Ranges, Mount Tamborine, and the Mistake and Bunya Mountains.
Giant barred-frog	Permanent freshwater streams from 0-700m in altitude, in rainforest and other forest communities of the McPherson, Main, D'Aguilar, Blackall and Conondale Ranges and the Bunya Mountains. Includes narrow riparian rainforest remnants along the following streams and their major tributaries: Maroochy River, Mary River, Stanley River downstream to Kilcoy, Caboolture River, Burpengary Creek, Coomera River and Nerang River.
Southern gastric-brooding frog and southern dayfrog	Permanent to ephemeral freshwater streams over 300m in altitude, in rainforest and wet sclerophyll forest communities of the Blackall, Conondale and D'Aguilar Ranges.
Kroombit tinkerfrog and Kroombit Tops population of cascade treefrog	Rainforest patches over 500m in altitude at Kroombit Tops (Kroombit Tops National Park and Kroombit Tops Forest Reserve).
Cascade treefrog	Permanent and semi-permanent freshwater streams, between 100-

	1000m in altitude, in rainforest and other forest communities of the McPherson, Main, Blackall and Conondale Ranges, Mount Tamborine, the Mistake Mountains and Girraween National Park.
New England treefrog	Permanent to ephemeral freshwater streams over 700m in altitude in Girraween National Park.

Existing conservation measures

The majority of known sites with threatened stream frogs occur in conservation reserves or state forest. Recovery actions, outlined in earlier recovery plans, have been implemented since 1998. Recovery tasks recently completed include:

- Surveys and monitoring across the geographical and environmental range of each species.
- Development and implementation of management prescriptions to protect threatened frog habitat.
- Investigation of the ecology of extant species.
- Increased awareness of the declining frogs problem through the provision of interpretive brochures and displays, public presentations and scientific publications.
- Increased community involvement in all aspects of the recovery process.
- Investigation of ill and dead frogs collected during monitoring or submitted by the public. Identification of the chytrid fungus as a possible threatening process.
- Development of captive husbandry techniques for Fleay's barred-frog at Lone Pine Koala Sanctuary.
- Collaborative projects with land care groups and local and state government agencies to more effectively manage the habitat of threatened stream frogs on private land.
- Collaborative projects with universities to carry out research into the ecology of, and threats to, the frogs.

Stakeholders affected by the plan

The seven frogs included in the plan occur mainly on lands managed under the *Nature Conservation Act 1992* or the *Forestry Act 1959*. Some habitat of the threatened frogs occurs on private land. The most poorly protected species is the giant barred-frog, as the habitat of its most significant populations, in the lower catchments of the Stanley and Mary Rivers, occurs almost entirely on private lands. Local community groups are facilitating recovery efforts in these catchments. Potential habitat for some of the species occurs on Commonwealth Land and extensive habitat occurs in World Heritage listed areas of south-east Queensland.

Timber harvesting has now ceased in most catchments where these frogs occur. Logging within state-managed forests must be compliant with The Code of Practice - Native Forest Timber Production. Specific protective measures for threatened species are provided in The Code through Species Management Profiles. Profiles have been developed for all frogs in the plan that are known to occur in timber production forests and will be reviewed periodically.

Potential habitat for some of the species in this plan occurs on Commonwealth land in the Army training area at Canungra. The recovery team has conducted some surveys in this area but more effort is required to determine the presence of

threatened frogs. The Army employs an environmental officer who has participated in the survey. The officer also undertakes rehabilitation of riparian rainforest communities in the training area.

An extensive area of potential and occupied habitat of three species occurs in the Central Eastern Rainforest Reserves (CERRA) World Heritage Area. The habitat includes sections of Springbrook, Lamington, Mount Barney and Main Range National Parks and Forest Reserves. The three species of frogs are recognised as making an important contribution to the World Heritage values of the Area.

The development of the plan has included consultation with and participation by interested parties. The recovery team also has established mechanisms for consultation of, and participation by interested parties. The recovery process outlined in this plan is unlikely to have any significant adverse social or economic impact.

Social and economic impacts. The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts.

International Obligations. Although the southern gastric-brooding frog *Rheobatrachus silus* is listed in Appendix II of CITES, this recovery plan does not affect Australia's obligations under international agreements. As the other species are not listed under any international agreement, the implementation of Australia's international environmental responsibilities in regard to these species is not affected by this plan.

Role and interests of indigenous people. Indigenous communities involved in the regions affected by this plan have not yet been identified. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

Other plans affected

The recovery plan will be influenced by the Queensland National Parks Master Plan. The Master Plan stresses that conservation of natural and cultural resources is the highest priority in park management, and sets guiding principles for the maintenance of natural integrity. Through the Master Plan, the recovery plan will be linked to a state-wide planning process incorporating strategic plans and policies for threatened flora and fauna.

Management plans or strategies are currently being prepared for national parks and forest reserves in south-east Queensland. These documents provide the framework for implementing the recovery actions from this plan in conservation reserves.

There are various mechanisms for the management and protection of World Heritage properties and values in CERRA. An overview of these is provided by Commonwealth of Australia (2000). Part of this strategy is the park management planning processes discussed above. World Heritage is considered a matter of national environmental significance for the purposes of the Commonwealth's *Environment Protection and Biodiversity Act 1999*. This legislation applies throughout CERRA to ensure the protection of World Heritage values (Commonwealth of Australia 2000).

Weirs and dams used as major surface water extraction sites occur within the habitat of the threatened frogs considered in this recovery plan. Many other streams could potentially be used for water extraction, or could be subject to regulation. The potential impact of existing or proposed water extraction on the frogs has not been examined. Queensland's statute law relating to the allocation and management of water is primarily contained in the *Water Act 2000*, administered by the Department of Natural Resources and Mines.

A new water allocation and management system is being established which provides a framework within which State-owned, semi-government and private water development can operate to provide for ecologically sustainable development. This new system of Water Resource Plans will progressively replace the existing licencing system. In south-east Queensland, Water Resource Plans are currently being prepared or implemented for the following catchments; Logan, Albert, Burnett, Boyne, Calliope, Mary, Burrum, Brisbane, Pine and Caboolture Rivers and the smaller catchments of the Sunshine and Gold Coasts.

Recovery team, reporting and review

The South-east Queensland Threatened Frogs Recovery Team is responsible for preparing, implementing and evaluating the recovery plan. Currently the recovery team includes representatives from QPWS, the Threatened Species Network, Lone Pine Koala Sanctuary and universities. Membership is reviewed periodically.

Progress in implementing the actions of the plan will be reviewed each year. Reports on implementation of the actions will be provided to the recovery team to facilitate the process. Where necessary, actions identified in the plan will be modified by the recovery team to incorporate new information.

The recovery plan will be fully reviewed at the end of the third year by the South-east Queensland Threatened Frogs Recovery Team and two independent reviewers.

Other biodiversity benefits

- Increased information on the ecology, habitat requirements, diseases and other threatening processes that have influenced the distribution and abundance of these frogs will assist in understanding the declines of amphibians in other parts of Australia and overseas.
- Amphibians are exposed to both terrestrial and aquatic environments during their life cycles and, having highly permeable skins, are highly susceptible to environmental changes. Consequently they are likely to be important indicators of environmental health.
- The frogs covered by the plan are important components of the forest stream trophic system, and fluctuations in their numbers may considerably influence the abundance and distribution of their food sources and predators. Understanding the causes of declines in these frog populations may contribute to improved catchment management in eastern Australia.
- Protection and management of habitat will benefit other rare or threatened flora and fauna (for example the threatened Richmond birdwing butterfly).
- Greater community awareness of the decline or disappearance of threatened frogs will raise the profile of all threatened species. This will in turn provide more opportunities for the conservation of threatened species and consequently, increased biodiversity benefits.

Strategy for recovery

Recovery of the threatened frogs considered in this plan is dependent on identifying the major threats and developing and implementing measures to ameliorate or eliminate their impact. Testing the hypothesis that disease is a major cause of the rapid declines of montane stream-dwelling frogs in eastern Australia is a significant aspect of the plan. To support this research, it is critical that ongoing monitoring of populations should continue. Other components of this plan will deal with the management of populations and their habitat in an effort to reduce impacts from other processes until the major threats are identified and reduced.

The number of species and the wide geographical area covered in the recovery plan, and the range of organisations involved, necessitates the appointment of a recovery co-ordinator to ensure that recovery actions are carried out effectively and efficiently.

Another critical part of the recovery process is the education and involvement of relevant land managers and the general public. Without government and community support, recovery of these species will not be possible.

Recovery objectives and criteria

Overall objective

To significantly improve the conservation status and long term survival of each species through protection of its habitat, and through location of additional populations or expansion of existing populations into areas currently uninhabited.

Specific objectives (2001-2005)

1. To down list the cascade treefrog from endangered to vulnerable within five years based on IUCN (2001) criteria of population size and trends, extent of occurrence and probability of extinction.
2. To determine whether the southern gastric-brooding frog and the southern dayfrog are extant.
3. To secure existing populations of extant species.
4. To investigate disease as a key threatening process.
5. To increase the number of populations of extant species by facilitating expansion into their former range.

Recovery criteria

1. Monitor three historical sites of the southern gastric-brooding frog and the southern dayfrog at least 10 times each, and survey at least 10km of potential stream habitat, by 2005.
2. If populations of the southern gastric-brooding frog and the southern dayfrog are located, population densities remain at or increase above the levels at which they were originally detected.
3. The role of disease in declines and disappearances is determined by 2005.
4. Interim strategies to reduce the risk of spreading amphibian diseases are developed and implemented by 2001 and revised as necessary thereafter.
5. Population densities of extant species remain at or increase above current levels at a selected subset of monitoring sites.
6. The distribution, abundance and conservation status of each species considered in this plan is more accurately known by 2005.
7. The cascade treefrog is down listed to vulnerable by 2005.

8. Reports are provided annually to the recovery team on the monitoring of population health and investigations of ill and dead frogs.
9. Captive husbandry techniques are developed for Fleay's barred-frog by 2005.
10. A project to investigate the captive husbandry requirements of the Kroombit tinkerfrog is commenced by 2005.
11. An assessment of the need for, and type of, experimental translocations of species in this plan is undertaken by 2002.
12. The genetic characteristics and diversity of each species is determined.
13. The effectiveness of current prescriptions for management of the habitat of the frogs in this plan is assessed and improved prescriptions developed.
14. There is increased protection and enhancement of the habitat of the frogs in this plan on private land through support of and expansion of community based conservation programs that target riparian environments in the Mary, Stanley and Caboolture River catchments by 2005.
15. Brochures, describing the species addressed in this plan and the threats to them, are developed and distributed through community groups and government agencies by 2001.
16. Displays on the frogs in this plan are developed and made available for use by Queensland Parks and Wildlife staff and community groups by 2002.
17. A web site is developed on the frogs covered by this plan and the causes of their declines by 2001.
18. A field identification guide for wet forest frogs of south-east Queensland is written and published by 2001.
19. Annual newsletter articles are prepared and distributed to recovery team members, relevant land managers and community groups.

Actions needed

Proposed tasks, which are subject to funding and staffing, are grouped under five recovery actions:

1. Manage the recovery process.
2. Monitor populations.
3. Gain information required for management.
4. Protect populations and manage habitat.
5. Provide education and information.

Recovery actions

The recovery actions are based on available knowledge and experience gained from implementing recovery plans for stream-dwelling frogs in eastern Australia. The South-east Queensland Threatened Frogs Recovery Team is responsible for the implementation and evaluation of this recovery plan. Progress in implementing the actions of the recovery plan will be reviewed each year. Where necessary, the recovery plan will be modified by the recovery team and/or relevant government agencies to incorporate new information. The recovery plan is to be reviewed by 2005.

Unless otherwise stated, the costs in this plan are estimates of the materials and consumables required to undertake tasks, and the salaries and associated costs of staff from the responsible agencies. They do not include in-kind contributions from volunteers and community groups. Proposed recovery actions and their component tasks are described below.

Action 1. Manage the recovery process

The aim of Action 1 is to provide the necessary framework for efficiently and effectively implementing the recovery plan.

1.1. Appoint a recovery co-ordinator

A full-time co-ordinator is needed to implement the recovery plan. The co-ordinator will liaise with appropriate government agencies, non-government organisations, land care groups, the public and other threatened frog recovery teams and researchers elsewhere in Australia. The co-ordinator will be a member of the recovery team and will report to QPWS. The co-ordinator will contribute to and integrate the outcomes of working groups, prepare the displays, web site and regular newsletters and co-ordinate the submission of grant applications and co-operative proposals to support the recovery process. Other duties will include organisation of recovery team and working group meetings and the circulation of agendas, minutes and discussion papers.

The co-ordinator will have access to all information arising from the implementation of actions in the plan. The co-ordinator will advise the recovery team on progress of actions and will facilitate the curating and analysis of data and its publication. The co-ordinator will help to implement those tasks of highest priority that are most directly associated with the core strategies, that is, research co-ordination, public education, development of media strategies and participation of volunteers. The position will help integrate the recovery program with programs for these frogs in New South Wales and Victoria where necessary.

1.2. Ensure effective recovery team functioning

The recovery team will meet twice yearly. Government agencies will meet the cost of attendance of their own representatives at recovery team meetings. Funds are required to support attendance of non-government organisation representatives attending meetings (travel, accommodation and meals), particularly when these are held outside Brisbane. Non-government organisation representatives currently contribute about 20 days per person per year in preparing for and attending recovery team meetings.

Cost of Action 1

Costs $'000s:	2001	2002	2003	2004	2005	Total
Total	73	73	73	73	73	365

Action 2. Monitor populations

Survey and monitoring is required to determine population trends, re-establish species or populations and locate previously unknown populations. Monitoring also provides valuable information on the prevalence of disease (Task 3.1) and on aspects of a species' ecology that are required for development of captive husbandry techniques (Task 3.2).

Three types of monitoring will be undertaken - intensive monitoring, extensive monitoring and surveys.

- Intensive monitoring of a small number of populations will be undertaken regularly during spring, summer and autumn. Frogs at these sites will be individually marked, sexed, weighed and measured, and habitat variables and environmental conditions will be recorded. Monitoring will be undertaken over several years and will provide detailed information on population dynamics and ecology.
- Extensive monitoring will be undertaken at a subset of sites where threatened stream frogs are known currently or historically. Sites will be selected across the altitudinal and latitudinal range of the species and will encompass a range of other habitat characteristics. These sites will be visited a number of times during the duration of this plan to assess the status of species over a broad geographical area, particularly with regard to disappearance or re-establishment of populations. The species, sex, and number of frogs will be recorded along a 100m transect using a standard method.
- Remote or previously unsurveyed areas, in which the distribution and/or abundance of populations is poorly known, will be targeted for surveys. The main aim of this type of monitoring is to locate new populations and to determine trends in distribution patterns of species over a greater geographical area. This task will be carried out opportunistically, often with the aid of large numbers of volunteers.

Community groups play an important role in this action. Programs and groups such as NatureSearch, Threatened Species Network and Queensland Frog Society provide training on frog identification and engage other community groups and private land holders. These groups provide a large pool of volunteers for monitoring tasks and also generate valuable distribution records of threatened frogs. Part of this action is to maintain and extend support to these groups and programs.

A considerable amount of monitoring has been undertaken in the last five years. A review of the data gathered so far is warranted, and if required monitoring programs will be revised.

Cost of Action 2

Costs $'000s:	2001	2002	2003	2004	2005	Total
Total	64	65	64	64	64	321

Action 3. Gain information required for management

The aim of Action 3 is to gather information to underpin recovery actions, management and policy.

3.1. Investigate the role of disease in frog declines

The south to north decline and disappearance of a number of Queensland's rainforest frogs, together with the collection of dead and dying frogs from Big Tableland in north Queensland, lead to the development of an hypothesis that the causal agent may have been a virulent pathogen. The pathogen may have first caused mortality in southern Australia, affecting species in southern Queensland in the mid to late 1970s.

Since 1996, dead and dying frogs of at least 10 species have been collected from south-east Queensland, including Fleay's barred-frog and the cascade treefrog. Examination of these specimens and those collected during declines on the Big Tableland and from Central America determined that the cause of death was a chytrid fungus (Berger *et al.* 1998, Berger *et al.* 1999).

A major investigation into diseases of Australian frogs and their role in amphibian declines is currently being co-ordinated by Professor Rick Speare at James Cook University. Protocols, results and reporting are provided on the amphibian diseases web site: *http://www.jcu.edu.au/school/phtm/PHTM/frogs*.

The monitoring component of this plan (Action 2) will contribute to the disease investigations through the provision of ill and dead frogs. Toe clips and other samples collected from apparently healthy frogs during monitoring will be used to assess the prevalence of chytrid fungus. In addition, QPWS will continue to collect specimens presented by the general community and forward them to the disease research project. Costs are included for collection and preservation of samples, transport of specimens to disease researchers and histology.

3.2. Develop captive husbandry techniques

The primary aim of this task is to develop husbandry skills for stream breeding frogs. In addition, the establishment of populations in zoological institutions, outside of the natural range of the species, may place some breeding populations beyond the influence of the factors(s) that caused declines. These two outcomes will provide a precautionary measure against the extinction of these species if they suffer declines in the future.

In conjunction with Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA) institutions, captive husbandry techniques will be developed for Fleay's barred-frog and the Kroombit tinkerfrog. Results of the work will form the basis of captive breeding plans for *ex-situ* management of these species, if such action is warranted. Information on the breeding biology of species in the wild (gathered during monitoring, Action 2), population dynamics and habitat usage (Tasks 3.5 and 3.6) will be provided to the institutions undertaking the projects. The

husbandry projects will also generate considerable information on the ecology of the species.

Offspring from successful captive husbandry programs can be used for re-introductions to establish new populations, for translocation experiments to test hypotheses regarding threatening processes and their abatement (e.g. Tasks 3.1, 3.3), or for display at zoological institutions to inform the community about the species and the threats to them. Release of captive bred animals into the wild (other than for experimental purposes to assist with determining causes of decline and/or assessing the effectiveness of potential amelioration measures) is not envisaged until the cause of the population declines has been identified and its effects reduced. The use of offspring will be at the discretion of Queensland Parks and Wildlife Service.

Interpretive displays will be developed and installed at each institution. The displays will provide information on the breeding biology of the species, the declining frogs problem, the role of captive husbandry in species recovery and the contributions of organisations to the project. This work will make a significant contribution to public information and education (Action 5).

3.3. Assess the need for translocation experiments

Translocation experiments may provide an insight into causes of the declines. A number of experiments could be considered. A translocation experiment is currently under way in the Wet Tropics, where declines have been most recent, using species that disappeared from higher elevations but persist in the lowlands (Northern Queensland Threatened Frogs Recovery Team 2001). Results of that experiment, together with information generated from monitoring and investigation under this plan, will be used to assess the need for, and type of, translocation experiments for threatened stream frogs in south-east Queensland. This assessment will be carried out in the third year. Costs in subsequent years will not be known until the assessment is completed, and if necessary, an experimental design is prepared.

3.4. Determine the genetic structure of populations

It is important that the systematics of the species is fully resolved and that the genetic diversity within taxa is known. This information will be used to prioritise populations for conservation in husbandry and translocation programs.

Barred-frogs

A study of allozyme variation in populations of barred-frogs revealed that the currently recognised species boundaries in south-east Australia are sound (Donnellan and Mahony, unpublished data). Studies of mitochondrial DNA diversity within each species will enable identification of evolutionary significant units. Ideally, at least 5 samples from each of the major populations of each species are required to carry out this work (e.g. for Fleay's barred-frog, samples would be required from Conondale Range, Bunya Mountains, Main Range, Mount Barney complex, McPherson Range, Lamington Plateau, Springbrook Plateau, Tamborine Mountain, Tooloom, Richmond and Nightcap Ranges and Mount Warning). Collection costs will be negligible as samples have already been obtained or can be gathered during monitoring (Action 2). Analyses will be performed in the fourth year of the plan to allow time to collect additional samples. Costs of analysis of mitochondrial DNA diversity assume that the work will be performed by a post-graduate student, using samples from up to twelve locations for each of the three species that occur in south-east Queensland.

Cascade treefrog

There has been considerable confusion over the systematics of the *Litoria barringtonensis*, *L. pearsoniana, L. phyllochroa,* and *L. piperata* complex. Studies of genetic variation in populations of this complex revealed that the currently recognised species boundaries are in need of major review (Donnellan *et al.* 1999). In other studies, species descriptions are being revised and diagnostic morphological and call characters are being studied so that specimen and non-specimen based records can be reviewed to determine the status of each species. No costs will be incurred as staff and students at the universities of Queensland and Newcastle, and the South Australian Museum are currently completing this work. If additional taxa are identified from this complex, they will be included in future revisions of the revisions of the recovery plan.

McGuigan *et al.* (1998) used mitochondrial DNA sequencing to determine that significant genetic divergence existed among populations of cascade treefrogs from different rainforest isolates. They concluded that populations to the north and south of the Brisbane River were sufficiently genetically distinct to be managed independently. However their study lacked specimens from important isolates: Blackall Range, the ranges to the west of Conondale Range and Girraween National Park. The cost of collecting samples from these populations will be negligible, as samples will be collected during monitoring (Action 2). Analyses will be performed in the fourth year of the plan to allow time to collect sufficient samples. Costs of analyses are based on the assumption that a post-graduate student, utilising samples from up to four locations, will perform the work.

3.5. Investigate population dynamics

Investigations of the population dynamics of declining frogs are necessary to assess the significance of changes in distribution and abundance determined during monitoring (Action 2). There is very little information on normal population fluctuations for stream-dwelling frogs of eastern Australia. Studies of population dynamics will also provide information on breeding success, age and sex structure, metapopulation processes and effect of disease outbreaks. These findings will help investigations into the cause of declines and assist in the development of husbandry techniques (Tasks 3.1 and 3.2) and have implications for translocations (Task 3.3). Costs included for this and the following task includes only the funds needed by the industry partner in two Ph.D. ARC LInkage scholarships, and the contribution made by a university researcher and a QPWS staff member to support such a project.

3.6. Determine habitat usage

The influence of habitat variables, including habitat disturbance and fragmentation, and the influence of native and exotic fish on the abundance and distribution of adult and larval stages and on breeding success, needs to be investigated. This information is critical for protecting and managing habitat (Action 4) and developing husbandry techniques (Task 3.2) This research will also assist in determining why some species of stream-dwelling frogs have declined and others have not.

Cost of Action 3

Costs $'000s:	2001	2002	2003	2004	2005	Total
Total	30	59	69	60	52	270

Action 4. Protect populations and manage habitat

Action 4 is aimed at reducing stresses on populations or habitat pending the identification and abatement of the major threatening process(es).

4.1. Assess effectiveness of management prescriptions

The effectiveness of current forestry management prescriptions in ameliorating disturbance to the habitat of these frogs needs to be assessed. The current management prescriptions are largely based on establishing riparian buffer zones. Radio- and spool-tracking studies of barred-frogs (Task 3.6) will provide the necessary information on movement behaviour and habitat usage on which to make the assessment. The task involves reviewing existing management prescriptions as information from Task 3.6 becomes available.

4.2. Control feral pigs

Control of feral pigs is required in the Conondale and Main Ranges and at Kroombit Tops. The Conondale Range provides habitat for five of the seven species covered by this plan, as well as a number of other threatened animals and plants. Damage from feral pigs has increased greatly in recent years. Although there may be direct predation by pigs, the greatest effect is likely to be the impact of increased silt on embryos and tadpoles. Streams in the area now carry heavy silt loads. Silt reduces the availability of food for tadpoles and reduces their fitness at metamorphosis. It is likely to be more significant for barred-frogs as their tadpoles take at least six months, and possibly up to 18 months, to develop. Soil disturbance by pigs is also likely to greatly increase the spread of riparian weeds such as mistflower and crofton weed (Task 4.3).

At Kroombit Tops, feral pigs have only recently arrived but they have caused significant damage to at least two sites known to support the Kroombit tinkerfrog. A control program was established in late 2000. At an intensive monitoring site for Fleay's Barred-Frog at Cunningham's Gap in Main Range National Park, damage from feral pigs was first noticed in April 2001. There were also reports of feral pigs farther north near Mount Mistake at this time.

Monitoring of pig damage and implementation of control measures will be undertaken. If necessary, a strategy will be developed for incorporating adjoining land holders and local government authorities in pig control programs.

4.3. Assess impact of crofton weed and mistflower on habitat

Mistflower *Ageratina riparia* and crofton weed *A. adenophora* are highly invasive weeds along wet forest streams. The effect of these weeds is not known, but they may have negative impacts on habitat (e.g. a reduction in the area of sites suitable for egg laying sites by Fleay's barred-frog). An assessment of impact is required, and if potential or actual significant impacts are identified, a strategy will be developed and implemented for control or elimination of the weeds in areas of significant frog populations. The strategy will include dissemination of information to private land holders through Landcare programs. Costs are only provided for the assessment. However, if a need for control is identified, additional funds will be required.

4.4. Manage populations of the giant barred-frog on private land

The vast majority of known populations of the giant barred-frog in south-east Queensland occur along narrow remnant riparian vegetation on private lands. Long-term conservation of the giant barred-frog in Queensland is dependent upon the maintenance of water quality and flow regimes, and on the protection and enhancement of riparian vegetation on these lands. Threats to water quality and altered flow regimes arise from adjacent and upstream land uses (e.g. housing development, stock grazing, clearing, agriculture, forestry practices). Extraction of water is also a potential threat. Remnant vegetation is threatened by clearing, disturbance from stock and weed invasion.

A collaborative project with land care groups and local and State government agencies is currently under way in the Belli and Cedar Creek catchment to address these issues. An important component in this project has been the provision of public education and information (Action 5).

Funding is sought to expand this project to include sites elsewhere in the Mary catchment and also in the Stanley and Caboolture catchments. Estimated costs include only materials for restoration work, as community groups and landholders will undertake much of the work.

A second component of this task is for the recovery team to provide support for applications by community groups for funding (e.g. Natural Heritage Trust and Threatened Species Network Grants) and to provide advice on management and restoration of the habitat of threatened frogs.

4.5. Reduce the impact of introduced fish

In south-east Queensland, introduced fish can seriously affect populations of stream breeding frogs through predation on eggs and tadpoles (Gillespie and Hero 1999). In New South Wales, predation by plague minnow *Gambusia holbrooki* has been listed as a Key Threatening Process for some frog species. In south-east Queensland, introduced fish have not played a role in the declines of stream breeding frogs. This is a precautionary task to protect populations of stream-frogs from future introductions. It involves the provision of information to relevant government agencies and the general public on the potential effects of fish translocations and introductions.

4.6. Manage fire at Kroombit Tops

The habitat of the Kroombit tinkerfrog comprises small patches of rainforest, often occurring as narrow strips along drainage lines, surrounded by eucalypt forest. Protection of this habitat involves the development and implementation of a fire management strategy for Kroombit Tops. This strategy will include planned burns to reduce fuel with the aim of preventing catastrophic wild fires.

4.7. Remove stock from the habitat of Kroombit tinkerfrog

Domestic and feral cattle and horses have long been present at Kroombit Tops. Within the habitat of Kroombit tinkerfrog, stock have been observed to cause fouling and gross physical damage to creek banks and adjacent seepages known to support the tinkerfrog. The impact of stock increases during dry periods.

In April 1996, a stock exclusion fence was constructed around former Scientific Area 48 in Kroombit State Tops Forest (currently Kroombit Tops Forest Reserve), to

protect biodiversity in the Scientific Area. At that time the fence enclosed the only three known populations of Kroombit tinkerfrog. Since then however it has not been possible to keep stock outside of the fenced area, largely due to trees falling onto and damaging the fence.

Over the next few years, Kroombit Tops Forest Reserve will be transferred to tenures administered under the *Nature Conservation Act 1992*, as part of the South-East Queensland Forest Agreement. The Recovery Team will provide advice on the management of threatened frogs at Kroombit, with the recommendation that stock be removed from a much larger area. This will provide for effective stock management in the habitat of the Kroombit tinkerfrog, and will permit the regeneration of other sites that are currently heavily affected by stock.

4.8. Provide advice to land managers

The threatened frogs in the recovery plan occur over a large area of south-east Queensland, on a range of land tenures with a diversity of land uses. The aim of this task is to ensure that adequate information and advice on the conservation needs of the frogs is available to land managers and decision makers. Through this task, members of the recovery team and staff of relevant government agencies will provide input into the various impact assessment and planning processes. These include Water Resource Plans, Park Management Plans and Environmental Impact Assessments. Land holders and community groups also need advice on habitat protection and restoration. The task will be strongly linked to Task 5.6 (provision of training workshops).

The second activity of the task is to develop a strategy for providing management information to land holders more efficiently. It will be undertaken by the recovery coordinator and the recovery team and will focus on the feasibility of producing and distributing a kit that includes information on each species, information on threats and management recommendations. The strategy is likely to result in the identification of additional tasks and costs.

Cost of Action 4

Costs $'000s:	2001	2002	2003	2004	2005	Total
Total	61	55	54	54	56	280

Action 5. Provide education and information

Community education, awareness and support are important components of the recovery plan. Frogs are poorly known or understood elements of our fauna and lack the high profile of many endangered species. Recovery of threatened frogs will be facilitated by increased community awareness of their declines and increased support for the research necessary to identify the threatening processes. Much work essential to the recovery of these species, such as research (Action 3), monitoring (Action 2), habitat protection (Action 4) and other work can only be effectively carried out through the involvement of volunteers, community groups and land holders.

Several approaches will be used to inform and involve the general community and attract volunteers. These include circulation of a fact sheet on threatened frogs and the recovery process, development of portable interpretive displays and a web site,

publication of an identification guide and regular newsletters, and holding of training workshops for land managers and volunteers.

5.1. Distribute fact sheet

A fact sheet on the declining stream-dependent frogs of mid-east Australia and the recovery process has been published (15,000 copies). These brochures will be distributed through conservation and land management agencies, community groups and at events where the portable displays are used (Task 5.2). Costs for the second year include provision for a third print run if required.

5.2. Develop and install displays

Portable public displays are needed to complement the fact sheet. These will be used to increase public awareness through installation at locations such as zoos, libraries, local government offices and schools and at special events (e.g. open days, World Environment Day). They will be available for use by conservation and land management agencies, local government, frog groups, land care groups, catchment management groups and other community groups. There has been considerable demand for such displays but none are currently available. Three colour displays will be prepared.

Cost includes use of images, design and production. The displays will be prepared by the co-ordinator (Task 1.1) in co-operation with members of the recovery team, community groups and conservation agencies.

5.3. Revise and expand web site

To complement the fact sheet and displays, a web site has been developed that provides detailed information on each of the declining frog species. The web site includes similar information to that provided in the species profiles in Appendix 1, as well as colour photographs. Links to other sites, such as the Amphibian Diseases web site and Environment Australia web site are also provided. Funding is needed in the second year of the project to review the content of the web site, to expand the number of species covered and to add in additional features such as recordings of calls. Publicising the web site, including development of links from related sites, will also be undertaken.

5.4. Publish identification guide

A colour identification guide to the wet forest frogs of south-east Queensland has been written. Funds have been provided by Griffith University to partially cover costs of layout and production. Further funds are required to publish and distribute the book. The aim of the book is to increase a) awareness of the declining frogs problem, b) knowledge of the declining stream frogs of south-east Queensland, c) interest in searching for these species and d) reliability of identification of sightings. The book will be an invaluable tool for training volunteers and land managers (Task 5.6). The guide will also provide information on reducing the risks of spreading frog disease.

5.5. Produce a regular newsletter

In order to improve communication between members of the recovery team, land managers, members of community groups and volunteers, the co-ordinator (Task 1.1) will produce a regular newsletter summarising progress of recovery activities. The newsletter will be circulated to the above groups and individuals for their information, and further distribution as they see fit, for example, through their newsletters. Costs include photocopying and postage.

5.6. Conduct training workshops

To ensure accuracy of identifications and consistency of methods, it is essential to train volunteers who participate in survey and monitoring activities (Action 2). To ensure effective habitat management, it will also be important to provide training to land managers (government agencies, community groups and private land holders) on the habitat requirements of frogs and threats to frogs, and on environmentally friendly land management techniques.

Training workshops for community groups and volunteers on stream frog identification and monitoring techniques will be held prior to conducting extensive monitoring (Action 2).

Cost of Action 5

Costs $'000s:	2001	2002	2003	2004	2005	Total
Total	8	21	9	4	4	46

Cost schedule

Estimated cost of implementing the recovery plan ($'000s)

Action	Action description	2001	2002	2003	2004	2005	Total
1	Manage the recovery process	73	73	73	73	73	365
2	Monitor populations	64	65	64	64	64	321
3	Gain information required for management	30	59	69	60	52	270
4	Protect and manage habitat	61	55	54	54	56	280
5	Provide education and information	8	21	9	4	4	46
	Total cost per year	236	273	269	255	249	1,282

Acknowledgements

Many people have contributed to the preparation of this recovery plan, especially past and present members of the various threatened frogs recovery teams that have operated in south-east Queensland and north-east New South Wales. This plan has been developed from four previous plans. The authors of these plans - Adrian Borsboom, John Clarke, Michael Cunningham, Keith McDonald and Wayne Martin, and all those who contributed to the preparation of those plans, are gratefully acknowledged. Figures used in Appendix 1 have been modified from Clarke *et al.* (1999), Hines *et al.* (1999), and Gillespie and Hines (1999). The Commonwealth Endangered Species Program, the Natural Heritage Trust and Queensland Parks and Wildlife Service provided funding for the preparation of a draft of this recovery plan. Sue Wright, Alastair Campbell, Liz Dovey and Brigitta Wimmer from Environment Australia assisted with funding applications and reviewed earlier plans.

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Appendix 1. Species profiles

Fleay's barred-frog *Mixophyes fleayi* Corben and Ingram 1987

Description

A large fossorial frog (snout-vent length 63-89 mm) with a steeply sloped, blunt snout. The dorsal surface is light to dark brown with indistinct darker marbling. A dark brown Y-shaped vertebral band with irregular edges starts between the eyes and extends to the vent, sometimes breaking up into a series of blotches along the mid-line. The sides are grey-brown, fading to yellow posteriorly and overlaid by a series of black spots. There is an irregular dark band running from the nostrils through the eye to a point behind the tympanum. There is a dark purple patch beneath the eye. The upper lip is usually mottled brown. The ventral surfaces of the body and limbs are typically yellow, the throat and underside of the thighs may be speckled with brown. Vocal sac present in males. The soles and palms are black.

The thighs are grey-brown, with 7-8 narrow, black cross-bands. The fingers are unwebbed, slightly expanded at the tips. The toes are half-webbed, possessing webbing to the base of the terminal phalanges of the first, second, and fifth toes, while two phalanges of the third toe, and those of the fourth toe are free of web but fringed. Palmar tubercles are rounded, well developed; inner metatarsal tubercle as long as first toe, outer metacarpal more elongate and about half the size of the inner.

Males develop dark brown nuptial pads on the prepollex, first and sometimes second finger. The pupil is vertical. In adults the upper part of the iris may be straw-brown through light blue to silvery-white. In sub-adults the upper third of the iris is flame orange. The tympanum is large and oval-shaped, sloping backwards. (Barker *et al.* 1995, Cogger 1996, Corben and Ingram 1987, Meyer *et al.* 2001).

Call

Mixophyes fleayi has two distinct calls, a throaty "ok-ok-ok-ok-ok-ok" made by solitary males, and a long, rasping "arrrrrrrr", or growling call given in chorus (Corben and Ingram 1987).

Reproduction

During favourable conditions, the species can form aggregations from late winter to early autumn, with breeding recorded in all months from July to March (Corben and Ingram 1987, QPWS unpublished data). Egg laying takes place in shallow riffle zones of streams. The female lays the eggs as a single layer on bedrock in flat, shallow sections of the stream, or forms a small depression amongst submerged leaf litter or gravel, and embeds the eggs in the walls of this 'nest' (Knowles, R., Thumm, K., Hines, H., Mahony, M. and Cunningham, M. unpublished data). Tadpoles are present year round at some sites (QPWS unpublished data).

Tadpole

The tadpole has been described by Meyer *et al.* 2001. Tadpoles are large, up to 100mm in total length. The body is fusiform and the tail length is twice that of body; eyes dorsolateral; uniform grey-brown above (later stage larvae may develop dark spots and splotches); underside silver-grey with silver-blue sheen; intestinal mass fully obscured, heart and gills barely visible; thick muscular tail; tail low-finned; fins opaque, heavily stippled with scattered dark spots/splotches; tail musculature light-brown/ grey with dark spots/splotches; limb buds and vent tube lie within translucent

'skirt' at base of tail; spiracle sinistral, opening lateroventrally; vent tube dextral; mouth sub-terminal; oral disc large, surrounded by papillae; labial tooth row formula 10(2-10) / 3(1).

Habitat

Adults may be found in leaf litter and along watercourses in rainforest and adjoining wet sclerophyll forests. Males call from rocks in streams or from pools at the margins of these streams (Corben and Ingram 1987) or from the forest floor (QPWS unpublished data). Females have been located well away from streams, over hundreds of metres from known breeding sites (QPWS unpublished data).

Distribution

Disjunctly distributed in wet forests over a restricted range from the Conondale Range south-east Queensland (26° 43´S 152° 35´E), south to Trynney Creek in the Richmond Range in north-east New South Wales (28° 48´S, 152° 44´E) (Hines *et al.* 1999, M. Graham NSWNPWS pers. comm.) (Figure 1).

Current distribution

Corben (in McDonald 1991) reported that *M. fleayi* declined in the Conondale Range in the late 1970s. Ingram and McDonald (1993) reported that it had not been seen in the Conondale Range since the summer of 1990-91. Since Ingram and McDonald's review, targeted surveys for *M. fleayi* have been undertaken and summarised by Hines *et al.* (1999) and Goldingay *et al.* (1999). A population was found in the upper reaches of three neighbouring streams in the Conondale Range, despite surveys of historical sites downstream that failed to locate the species. In Queensland other populations are currently known from the Lamington plateau and the northern section of Main Range, the Mount Barney area and Currumbin and Tallebudgera Creeks below Springbrook Plateau. There have been no records of *M. fleayi* from the extensively developed Mt Tamborine area since 1976, despite targeted surveys. There is a museum specimen of *M. fleayi* collected from the Bunya Mountains in 1970 (Hines, in press). Recent targeted surveys there have failed to locate *M. fleayi*.

In New South Wales the species is known from, Yabbra and Tooloom Scrubs, Mt Warning (Breakfast Creek), Terania and Tuntable Creek catchments in the Nightcap Range, and Levers Plateau, Sheepstation and Brindle creeks in the Border Ranges. Over two summer seasons there were no sightings of *M. fleayi* at Terania Creek despite intensive searches, and prior to this only very low numbers had been observed. Subsequently, the species was located at that site during targeted surveys in early 1999 (Goldingay *et al.* 1999).

Mixophyes fleayi has disappeared from some sites in Queensland and possibly from some sites in New South Wales. Whether populations have declined at other sites is difficult to assess, due to a lack of historical records of relative abundance. The very low numbers recorded from many well surveyed sites suggest that declines in abundance may have occurred.

Threats

The reasons for declines and disappearances of *M. fleayi* populations are not known. Large areas of this species' habitat have been and continue to be degraded by feral animals (e.g. feral pigs in the Conondale Range), domestic stock (Main Range) and invasion of weeds. Upstream clearing, timber harvesting and urban development (e.g. Mt Tamborine) are all likely to have affected flow regimes and water quality. A

chytrid fungal disease has been identified as the cause of illness and death of *M. fleayi* on Main Range and Lamington plateau (Berger *et al.* 1998).

Conservation status:

Mixophyes fleayi is currently listed as Endangered in the Action Plan, nationally and in both Queensland and New South Wales. It meets IUCN (2001) criteria for Endangered [B2ab(iii)].

Existing conservation measures

A captive husbandry project has been initiated at Lone Pine Koala Sanctuary.

Giant barred-frog *Mixophyes iteratus* Straughan 1968

Description

A very large frog (snout-vent length up to 115 mm) with a pointed snout and well developed hind legs. The dorsal surface is dark brown to olive, with darker blotches and an irregular dark vertebral band commencing between the eyes and continuing posteriorly. A dark stripe runs from the snout, through the eye and above the tympanum, terminating at a point above the forelimb. There are irregular dark spots or mottling on the flanks. The limbs have a series of dark and pale crossbars of similar width. The hidden part of the thigh ranges from black with a few large, yellow spots to being marbled black and yellow. The ventral surface is typically yellow with fine brown mottling on the chin. The pupil is vertical, while the iris is pale silvery-white to pale gold above, darker in the lower portion. The fingers lack webbing, while the toes are fully webbed, with only the last two joints of the fourth toe free. The outer metacarpal is poorly developed; the inner metatarsal tubercle is well developed, but only half as long as first toe. The skin is finely granular above, smooth below. The tympanum is distinct. (Barker *et al.* 1995, Cogger 1996, Straughan 1968, Meyer *et al.* 2001).

Call

The call is a deep guttural grunt (Barker *et al.* 1995, Robinson 1993). Males call from the forest floor or from crevices under rocks, banks or overhanging tree roots (Cogger *et al.* 1983, Straughan 1968).

Reproduction

Straughan (1966) provides limited information on the reproductive biology of this species. Males call during the warmer months (September to April). Amplexus is axillary. Tadpoles are present throughout the year and probably over-winter. Laboratory reared tadpoles metamorphosed at 28-30mm. A gravid female was found to carry 4184 eggs with a mean diameter of 1.6mm (Hero and Fickling 1996).

Tadpole

Meyer et al. 2001 has described the tadpole. Tadpoles are large growing to over 100mm in total length. They are deep-bodied, ovoid; tail length twice that of body; eyes dorsolateral; yellow-brown above with dark spots/ splotches and dark patch at base of tail; underside silver-white; intestinal mass obscured, heart and lungs visible from below (except near metamorphosis); tail thick and muscular; low-finned; fins opaque with dark flecking (except anterior half of ventral fin); tail musculature with dark flecking/spots and/or splotches; spiracle sinistral, opening lateroventrally; vent tube opening dextral; oral disc surrounded by papillae; labial tooth row formula: 6(3-6)/3 (1).

Habitat

Occurs along shallow rocky streams in rainforest, wet sclerophyll forest and farmland between 100 and 1000m (Covacevich and McDonald 1993) or deep, slow moving streams with steep banks in lowland areas (QPWS unpublished data). A short term study of the patterns of daily movement of this species during the breeding season showed that individuals moved up to 100m in a night, but not more than 20m from the stream (Lemckert and Brassil 2000). Longer term studies that include non-breeding times are required to adequately assess habitat usage of *M. iteratus*.

Distribution

From Belli Creek near Eumundi, south-east Queensland (26° 31´S 152° 49´E), south to Warrimoo, mid-east New South Wales (33° 43´S 150° 36´E) (Hines *et al.* 1999) (Figure 2). Cogger (1996) states that *M. iteratus* was distributed south "to about Narooma" (36° 13´S 150° 08´E), but there are no specimens or other records this far south to substantiate the statement.

Current distribution

Hines *et al.* (1999) reviewed the current distribution of *M. iteratus*. It has suffered major declines in the southern portion of its range. There are no recent records from the Blue Mountains, although there were only a few historical records in that area. In the Watagan Mountains, *M. iteratus* is currently known from several small populations, but appears to have disappeared from the central and western parts of the area (White 2000). Although not common there in the past it was frequently recorded. Between the Hunter River and Macleay catchment there is currently only one known population, at Mount Seaview, but survey effort in this area has been relatively low. There were only two confirmed historical records in that area (Upper Allyn River and Middle Brother State Forest). A population was recently located in the southern Nambucca River catchment. North of this there are currently a substantial number of populations in the Dorrigo-Coffs Harbour area, North Washpool State Forest and Bungawalbin State Forest. Despite surveys in far north-east New South Wales, *M. iteratus* is known from only three areas - several streams in Mebbin State Forest, Peacock Ck in Richmond Range, and Rocky Creek in Nightcap Range (Goldingay *et al.* 1999).

In south-east Queensland, *M. iteratus* is currently known from scattered locations in the Mary River catchment downstream to about Kenilworth, Maroochy River, Upper Stanley River, Caboolture River, Burpengary Creek and Coomera River.

The Bunya Mountains and Cunningham's Gap previously supported *M. iteratus* (Straughan 1966, Australian Museum specimens) but these and nearby sites have recently been the subject of targeted survey or intensive monitoring, without locating the species. During the early 1980s, *M. iteratus* disappeared from two streams in the Conondale Range. It was not recorded during monitoring of these sites between 1996 and 2000. In early 2001 three *M. iteratus*, including a juvenile, were located during monitoring at one of these sites. This may be evidence of recovery in this section of the Conondale Range. Assessing the extent of the decline in Queensland is difficult because of the lack of historical data on its distribution and abundance.

Threats

Many sites where *M. iteratus* occurs are the lower reaches of streams that have had major disturbances such as clearing, timber harvesting and urban development in their headwaters. In the Dorrigo area (north-east New South Wales), Lemckert (1999) found that *M. iteratus* was less abundant in recently logged areas and at sites where there was little undisturbed forest. The impacts of the chytrid fungus, upstream clearing, changes in water flow regimes, degradation of water quality, feral animals, domestic stock, weed invasion and disturbance to riparian vegetation, all potential threats to current populations, are unknown. Individuals of *Mixophyes iteratus* have sometimes been killed in the mistaken belief that they are the introduced cane toad *Bufo marinus*.

Conservation status

Mixophyes iteratus is currently listed as Endangered in the Action Plan, nationally, and in both Queensland and New South Wales. It meets IUCN (2001) criteria for Endangered [B2ab(iii)].

Southern gastric-brooding frog *Rheobatrachus silus* Liem 1973

Description:

A moderately large, aquatic frog, males 30-44mm, females 41-54mm (Ingram 1983, Tyler and Davies 1983a). The dorsal surface is brown, or olive brown to almost black, usually with obscure darker blotches on the back. A dark streak runs from the eye to base of the forelimb. There are darker cross-bars on the limbs, and pale and dark blotches and variegations on the digits and webbing. The ventral surface is white or cream with yellow markings on limbs. Skin is shagreened or finely granular above, and smooth below. Snout is blunt and rounded, with the eyes and nostrils directed upwards. Eyes are large and prominent, located close together and close to the front of head. The tongue is largely adherent to the floor of mouth and the tympanum is hidden. Fingers lack webbing, while toes are fully webbed. Digits have small discs. (Cogger 1996, Liem 1973, Tyler and Davies 1983a)

Call

Call is a loud staccato, consisting of 30-34 pulses repeated in a long series, lasting 260-290 ms. Dominant frequency is 1000Hz, with less emphasised frequency bands at 500,700,1200 and 1400Hz (Tyler 1983b).

Reproduction

Breeding activity occurs between October and December and appears dependent upon rains (Ingram 1983). This species has a unique reproductive mode in which eggs or early tadpoles are swallowed by the female and complete their development in the stomach (Tyler and Carter 1982). Hormones produced by the young inhibit the digestive secretions of the stomach and inactivate the upper intestine, a process of special interest to the medical community (Tyler 1985). Tadpoles rely on yolk reserves throughout development (Tyler and Davies 1983b). Up to 25 young are brooded in this fashion, emerging from the mother's mouth as fully formed metamorphs after about six or seven weeks (Tyler and Davies 1983b). The digestive tract returns to its normal state and the female recommences feeding within four days (Tyler 1983a). Maximum longevity is at least three years (Ingram 1983).

Tadpole

The tadpoles are reared in the stomach of the female frog and are therefore quite unusual. They are bulbous, pale and low finned without keratinised mouthparts (Tyler and Davies 1983b).

Habitat

Rheobatrachus silus is an aquatic species and has never been located more than four metres from water. This species is restricted to rocky perennial streams, soaks and pools in rainforest and tall open forest with a closed understorey. It prefers rock pools and backwaters with leaf litter and rocks in which to shelter (Ingram 1983)

Rheobatrachus silus is most active during the warmer months, between September and April, with abundance decreasing as conditions become drier in winter (Ingram 1983). It is not known where these individuals go during winter, but it is believed they hibernate in deep crevices in the rocks (Ingram 1983, Liem 1973). Individuals may be active night or day, particularly after rain. They establish home ranges in and around suitable pools, spending extended periods partly submerged and immobile. When

heavy rain falls the males move away from the water, sometimes up to four metres, and call from sheltered hollows or crevices above the pools (Ingram 1983).

Distribution

Restricted to elevations of 400-800m in the Blackall and Conondale Ranges, south-east Queensland, between Coonoon Gibber Creek (26° 33'S, 152° 42'E) and Kilcoy Creek (26° 47'S, 152° 38'E) (Hines *et al.* 1999) (Figure 3).

Current distribution

Not sighted in the wild since 1981 despite continued efforts to relocate the species. Since Ingram and McDonald's (1993) review, the following surveys and monitoring for this species have been undertaken (summarised by Hines *et al.* 1999):

(a) Regular monitoring at Ingram's (1983) study site - Beauty Spot 100 on Booloumba Creek, Bundaroo, Peters and East Kilcoy Creeks in the Conondale Range and at Picnic Creek (the type locality near Kondalilla) on the Blackall Range.

(b) 1995 intensive "frog search" of Conondale Range.

(c) 1997 "frog search" of the headwaters of Kilcoy, North Booloumba and Bundoomba Creeks, Conondale Range.

(d) Since 1996, systematic surveys of many streams in the Conondale and Blackall Ranges. Some sections of streams were visited on many occasions over a range of weather conditions. Poorly surveyed streams in the Upper Stanley River were targeted.

(e) Opportunistic surveys by various frog biologists.

The species declined rapidly in late 1979, with only a single specimen located after that, in 1981 (Richards *et al.* 1993).

Threats

The reason(s) for the disappearance of this species remains unknown (Tyler and Davies 1985). Populations of *R. silus* were present in logged catchments between 1972 and 1979. Although *R. silus* persisted in the streams during these activities, the effects of timber harvesting on this aquatic species were never investigated. Its habitat is currently threatened by feral pigs, invasion of weeds (especially mistflower *Ageratina riparia*), and altered flow and water quality due to upstream disturbances.

Conservation status

It is listed as Presumed Extinct nationally, and as Endangered in Queensland and in the Action Plan. *Rheobatrachus silus* meets IUCN (2001) criteria for Presumed Extinct.

Southern dayfrog *Taudactylus diurnus* Straughan and Lee 1966

Description:

Small diurnal frog, males 22.0-27.2mm, females 23.3-30.6mm snout-vent length (Liem and Hosmer 1973). Dorsal surface is grey or brown with darker mottling. There is a pale bar between the eyes, bordered behind by a dark brown patch. A short dark stripe runs from the eye to the base of the forearm, sometimes with a pale band bordering the lower edge. A dark, irregular, slightly raised H-shaped mark is present over the shoulders, and an irregular pale patch may be present over the pelvic region. The limbs have irregular dark cross-bands. The ventral surface is cream, yellowish-white or blue-grey, with or without grey spots. The throat is more heavily spotted or mottled with grey, sometimes appearing grey with yellow spots. Its skin is smooth, finely granular, or with a few low warts above and is smooth below. The digits have wedge-shaped discs and are unwebbed, though toes have broad fringes. (Cogger 1996, Liem and Hosmer 1973, Straughan and Lee 1966).

Call

Although the species lacks vocal sacs, a call is emitted which resembles a soft chuckling, repeated 1-2 or 4-5 times in quick succession every 4-5 mins, reminiscent of *T. eungellensis* and the chuckle call of *T. acutirostris* (Ingram 1980, Liem and Hosmer 1973, McDonald pers. obs.).

Reproduction

Active *T. diurnus* have been observed year round, although less frequently during cooler winter months (Czechura and Ingram 1990). Breeding occurs in warm weather, after or during heavy rain, between October and May, peaking in the January to March period (Czechura and Ingram 1990, Straughan and Lee 1966). Amplexus is inguinal and the eggs are deposited in gelatinous clumps under rocks in the water (Czechura and Ingram 1990). The tadpoles may be found year round and are bottom dwellers, feeding by scraping food from the substrate (Liem and Hosmer 1973).

Tadpoles

Tadpoles are moderately sized, with an umbrella-shaped lip, with the labial papillae completely surrounding the labium. There are no labial teeth (Liem and Hosmer 1973).

Habitat

Taudactylus diurnus inhabits montane rainforest, tall open forest and other riparian vegetation with a closed understorey along permanent and temporary streams at elevations between 350 and 800m (Czechura and Ingram 1990). It prefers permanent streams with a rocky substrate, but will use streams with a wide variety of substrates provided the water is not very muddy (Czechura and Ingram 1990). Active frogs may be found amongst low vegetation, rocks, leaf litter and other debris, generally within 10m of water, although they have been recorded more than twice this distance from water in wet weather (Czechura and Ingram 1990). Individuals have frequently been observed to enter water, swimming from point to point or sitting half-submerged (Czechura and Ingram 1990). At night they shelter under rocks and debris or within crevices (Czechura and Ingram 1990).

Taudactylus diurnus is a diurnal species. Activity begins at sunrise and ceases soon after sunset (Ingram 1980). This species is generally very active, but will sit motionless for periods while basking in sunlit patches or on warm rocks (Czechura

and Ingram 1990). Individuals escape danger by leaping into the water and swimming away, or hiding on the bottom amongst rocks or mud (Czechura and Ingram 1990). Activity in *T. diurnus* appears to be restricted by temperature, and it is intolerant of desiccation (Johnson 1971).

Distribution

Occurred in disjunct populations in the Blackall, Conondale and D'Aguilar Ranges south-east Queensland, from Coonoon Gibber Creek in the north to Mount Glorious in the south (26° 33'S, 152° 42'E - 27° 23´S, 152° 47´E) (Hines *et al.* 1999) (Figure 4).

Current distribution

Not sighted in the wild since 1979 despite continued efforts to relocate it. Since Ingram and McDonald's (1993) review, the following surveys and monitoring for the species have been undertaken (summarised by Hines *et al.* 1999):

(a) *T. diurnus* was present at most sites at which *R. silus* occurred, so surveys and monitoring for that species (see above) were likely to detect *T. diurnus*.

(b) Regular (near fortnightly) diurnal monitoring at the type locality (Greene's Falls) and nearby streams at Mount Glorious by Brisbane Frog Society for a year (1995-1996).

(c) A study of *L. pearsoniana* at the head of Love Creek at Mount Glorious, since September 1995, failed to detect *T. diurnus* despite some diurnal censuses and regular tadpole surveys.

Threats

As is the case for *R. silus*, the reason(s) for the disappearance for *T. diurnus* remains unknown (Martin, McDonald and Hines 1997). Its habitat is currently threatened by feral pigs, invasion of weeds (especially mist flower) and altered flow and water quality due to upstream disturbances.

Conservation status

It is listed as Presumed Extinct nationally, and as Endangered in Queensland and in the Action Plan. *Taudactylus diurnus* meets IUCN (2001) criteria for Presumed Extinct.

Kroombit tinkerfrog *Taudactylus pleione* Czechura 1986

Description

Taudactylus pleione is a small frog, with adults growing to a snout-vent length between 25-35mm. It is reddish brown to grey dorsally with darker brown flecks, spots and blotches. Of these dark markings there is a prominent broad bar of approximately uniform width between the eyes, a roughly X-shaped blotch between the shoulders, broad lateral bands and a bar or blotch either side of the groin. A broad dark lateral stripe extends from the snout through the eye and ear. Limbs and digits have conspicuous dark cross-bars and digits are not webbed. The toes are indistinctly flanged. The posterior surface of thighs is dirty yellow, with brown bars and specks. The venter is smooth, translucent grey with dense cream and brown mottling and speckling. (M. Cunningham unpublished data, Czechura 1986a, Meyer *et al.* 2001)

Call

The call is a high-pitched 'tink-tink-tink-tink...', fast at first, slowing towards the end (Meyer *et al.* 2001).

Reproduction

Taudactylus pleione has been heard calling from September until early March, with peaks in calling most likely on warm nights between December and February. During winter the species appears to be inactive and possibly hidden deep inside rocky shelves or under large boulders. During the suspected summer breeding season, calling activity varies from night to night but is generally strongest at dusk and early evening, with infrequent calls in the afternoon. When calling vigorously, males may call all night and into the following day. Frogs have been seen or heard calling from rocky perches, crevices or forest debris within close proximity to watercourse channels or intermittent seepages, and are usually at least partially sheltered by leaves or rocks. (Clarke *et al.* 1999, QPWS unpublished data, Tangey and Clarke in press)

There is virtually no information on the female breeding cycle, although there are three records of gravid females, one (the holotype) collected early February, the second seen in mid-January and the third, with partially developed eggs, in December. Eggs, oviposition sites, and tadpoles have not been described. (Clarke *et al.* 1999, Meyer *et al.* 2001, QPWS unpublished data)

Tadpoles

Unknown.

Habitat

Recorded only in small, narrow, isolated patches of gully rainforest. Found amongst or under rocks and leaf litter in the vicinity of permanent and ephemeral, rocky seepage zones. Vegetation at sites on the plateau is dominated by *Ceratopetalum apetalum,* and/or *Archontophoenix cunninghamiana* often with emergent *Araucaria cunninghamii*. Wet sclerophyll species including *Eucalyptus saligna* and *Lophostemon confertus* occur along the rainforest margins but are replaced by drier forest eucalypts further up-slope. Populations below the escarpment occur in steep boulder strewn drainage lines that are dominated by *Archontophoenix cunninghamiana* closed forest with emergent *Araucaria cunninghamii* and other rainforest trees. (Borsboom *et al.* 1999, Clarke *et al*. 1999, Cunningham and James 1994, Czechura 1986a)

Distribution

Taudactylus pleione is currently known from only nine small patches of rainforest at Kroombit Tops west of Miriam Vale in south-east Queensland. Three of these are isolated patches between 800-850m altitude on separate drainage lines of the headwaters of Kroombit Creek. These patches are in Kroombit Forest Reserve (formerly Scientific Area 48 in Kroombit Tops State Forest). The frog was recently located in six rainforest patches on the headwaters of Degalgil and Diglum Creeks in the Boyne River catchment. These patches are in Kroombit Tops National Park just below the escarpment adjacent to Kroombit Tops Forest Reserve. The total area of known frog habitat is approximately 140ha. The nine occupied patches are estimated to be scattered within an area of about 700ha, (Figure 5). (Clarke *et al*. 1999, Cunningham and James 1994, Czechura 1986a, Czechura 1986b, QPWS unpublished data)

Current distribution

The only intensively monitored population, at the head of Kroombit Creek, appears to have declined. At this site the species was regularly encountered prior to 1997 but was not heard or seen during the 1997/98 season despite systematic monitoring. The frog was heard at three other sites during limited surveying and monitoring in the 1997/98 season (Hines *et al.* 1999). The site has been monitored regularly since and *T. pleione* has only been heard on one occasion (QPWS unpublished data).

In the 1997/98 season automated tape recorders were installed at the monitoring site to increase survey effort. Recordings were also made in the 1998/99 and 1999/2000 seasons. During this time *T. pleione* was not heard on any of these recordings but it was regularly detected at another site using the same methods (QPWS unpublished data).

Threats

Potentially vulnerable to the unknown causal agent(s) that have resulted in the decline or disappearance of several species of frogs including four of the six *Taudactylus* species from rainforest streams in Queensland over the last 15 years (Ingram and McDonald 1993, Hines *et al.* 1999).

Likely to be susceptible to trampling and increased nutrient loads resulting from grazing in, and upstream of, habitat areas. Trampling may also alter the hydrology of seepage areas. Very likely to be susceptible to predation and habitat destruction by pigs. Pigs have recently become established at Kroombit Tops, and have caused significant damage to at least two sites occupied by *T. pleione*. The effect of this damage is not yet known. A wildfire in 1984 caused significant damage to a number of the small rainforest pockets from which *T. pleione* is known. Management of fire at Kroombit Tops is critical to the conservation of *T. pleione*. (Borsboom *et al.* 1999, Clarke *et al.* 1999)

Conservation status

It is listed as vulnerable nationally, in Queensland and in the Action Plan. A review of its legislative status is urgently required as it meets IUCN (2001) criteria for Critically Endangered [B1ab(iii, iv)].

Cascade Treefrog *Litoria pearsoniana* (Copland 1961*)*

Description:

A small frog, males 24-29mm and females 31-37mm snout-vent length. Dorsal coloration highly variable, and can change seasonally. Ranges from green, through various combinations of green and brown to dark brown, with or without black spots or reticulations. A thin pale stripe runs from the nostril, through the eye, passes above the tympanum and continues along the flank to the mid-body. This stripe is bordered below by a brown band, broadening as it extends along the flank to the mid-body. There may be a pale stripe along the upper lip. The tympanum is distinct and usually brown in colour. The ventral surface is white or cream. The hidden parts of the groin and thighs are yellowish tan to brick red. The skin is smooth or shagreened above, granular below. The fingers and toes have well developed discs, but only the toes have extensive webbing. (Copland 1960, McDonald and Davies 1990, Meyer *et al.* 2001).

Call

The mating call is a diphasic three note call lasting for 0.8 to 1.8 seconds; “Weeeak kuk kuk”. Variations include: a very slow version of the first part of the call heard early in the evening, the first part of the call is made by one male and a second male completes the sequence, and individuals may merely repeat the last two notes several times. (McDonald and Davies 1990).

Reproduction

Reproductive activity occurs from August to April, peaking from October to early February. Females may possess the ability to breed more than once in a season. Amplexus is axillary, taking place near egg laying sites. Eggs are deposited in a clump of several hundred, attached to rocks, debris or aquatic plants in still, shallow pools adjacent to, or connected with the main stream. The eggs are dark, 1.1-1.3mm in diameter and are covered in a clear jelly capsule 3.0-3.5mm in diameter, generally obscured by grey or brown silt. Eggs hatch three to five days after spawning. Metamorphosis typically occurs two to two and a half months later, depending on temperatures (McDonald and Davies 1990).

Tadpoles

Tadpoles are about 30mm long when metamorphosis commences. The dorsal surface is a light golden colour during early stages, darkening to brown; some specimens develop dark spots in the later stages. The ventral surface is unpigmented. The body is broader than deep with the greatest breadth behind the eyes. The mouth is ventral with two upper and three lower rows of labial teeth, with a median gap in the inner-most rows. Labial papillae surround the lateral and posterior margins of the mouth. The tail is moderately thick and has a rounded tip. The fins are transparent with dark spots. (McDonald and Davies 1990).

Habitat

Inhabits streams in rainforest and adjacent wet sclerophyll forest at elevations of 200-1000m in south-east Queensland and north-east New South Wales. Activity is predominantly nocturnal, peaking on warm nights during and after rain, but the frogs may also be active on warm overcast days. Males call from low perches up to one metre above water, retreating to humid crevices during the day. During winter frogs may form large, mixed sex, aggregations in humid crevices with relatively stable temperatures. Within these crevices, hibernating animals, lethargic in behaviour with

their eyes closed, form closely packed groups, with dorsal and ventral surfaces pressed against the crevice walls to reduce surface area (McDonald and Davies 1990).

Distribution

Kandanga State Forest south-east Queensland (26° 26´S, 152° 24´E) south to Gibraltar Range north-east New South Wales (29° 31´S, 152° 25´E) (Hines *et al.* 1999) (Figure 6). Recent allozyme and DNA studies (Donnellan *et al.* 1999) indicate that the isolated population of *L. pearsoniana* at Kroombit Tops (24° 24´S, 151° 01´E - Figure 5) is genetically distinct and is an evolutionary significant unit (see Moritz 1994).

Current distribution

Czechura (1991) and McDonald and Davies (1990) recorded declines of *L. pearsoniana* in the late 1970s to early 1980s from the Conondale and Blackall Ranges in south-east Queensland. Corben (in McDonald 1991) suggested that this species had not suffered a conspicuous decline in the Conondale Range, but that it had disappeared from some streams in Brisbane Forest Park. Ingram and McDonald (1993) found *L. pearsoniana* breeding in small numbers in the Conondale, Border and Main ranges. During their survey, only two *L. pearsoniana* were heard during ideal weather conditions at East Kilcoy Creek (K. McDonald unpublished data) where it had previously occurred in hundreds during the study of McDonald and Davies (1990). Ingram and McDonald (1993) did not find it at Kondallila Falls in the Blackall Range, although it was common there in the 1970s (K. McDonald unpublished data). There are no reports of declines in New South Wales.

More recent studies have found the species to be reasonably widespread (summarised by Hines *et al.* 1999) with recovery at some sites. However, at other sites where seemingly suitable habitat exists, *L. pearsoniana* is currently at low densities. There are no recent records from sites at Girraween National Park where it was known historically, despite targeted surveys there.

Threats

The reasons for population declines are unknown. In the Blackall and Conondale Ranges the declines coincided with the period during which *T. diurnus* and *R. silus* disappeared. Large areas of this species' habitat have been degraded and continue to be degraded by introduced animals, e.g. feral pigs and domestic stock, invasion of weeds and timber harvesting (see Parris and Norton 1997 for discussion). Upstream clearing and urban development have reduced habitat and are likely to have affected downstream flow regimes and water quality in some localities (for example Kondallila Falls). *Litoria pearsoniana* is known to form large aggregations during winter (McDonald and Davies 1990); destruction of these sites may have severe local impacts on populations. Infections of a chytrid fungus (Berger *et al.* 1998) have been found on dead individuals from Main Range in south-east Queensland and from the population at Kroombit Tops. Other ill and dead *L. pearsoniana* have been found in the Conondale Range but these have not yet been examined to determine the cause (Hines *et al.* 1999).

Conservation status

Litoria pearsoniana is currently listed as Endangered in Queensland but is not considered threatened in New South Wales or nationally. It is listed as Insufficiently Known in the Action Plan, and meets IUCN (2001) criteria for Least Concern. Reassessment of its legislative status in Queensland, based on a more thorough analysis of recent survey and monitoring data, is warranted. Resolution of taxonomic

problems within the species group is needed, particularly for the population at Kroombit Tops.

New England treefrog *Litoria subglandulosa* Tyler and Anstis 1975

The taxonomy of *Litoria subglandulosa* has recently been reviewed (Mahony *et al.* 2001). This profile is concerned with *Litoria subglandulosa sensu stricto* unless otherwise stated.

Description

A medium sized frog, males up to 40mm snout-vent length, females to 50mm. Dorsal surface is predominantly green with beige and or gold patches and scattered darker mottling. A narrow stripe (gold or beige in colour) runs from the nostril back through the eye, over the tympanum and down the flanks. Below this stripe runs a broad, dark stripe extending to, and encompassing the flanks. The dorsum is smooth. The groin and posterior thighs are translucent yellow in colour. The upper lip is white and the tympanum is the same shade of green as the surrounding skin. The tips of fingers and toes have distinct disc-like pads. The toes are almost fully webbed and the fingers have no trace of webbing. (Anstis and Littlejohn 1996, Mahony *et al.* 2001, Tyler and Anstis 1975)

Call

The call is a series of moderately low-pitched notes ‘orak-orak-orak…’, and varies in speed, accelerating at first then slowing after climax. Diurnal calling is common during the breeding season (October-November), with males typically calling from under rocks and crevices and from within vegetation. At night males usually call from perched positions on trees and shrubs approximately 0.5-1.5m above streams. (Anstis and Littlejohn 1996)

Reproduction

Reproductive activity occurs in late spring (October-November). Amplexus is axillary, egg masses are laid in streams and attached to the surface of submerged branches or rocks, just below water level. Egg masses are compact in form and highly adherent to suit lotic environments. Tadpoles are found in shallow, slowly moving sections of the stream on sand and submerged rocks or leaf litter. They probably feed on flocculant silt and algae. (Anstis and Littlejohn 1996).

Tadpoles

Tadpoles of this species and the closely related *Litoria daviesae* are highly distinctive from all other species of *Litoria* - the mouth is surrounded by long papillae and lacks teeth and the horny beak. The mouth is sub-terminal and funnel shaped. Maximum length of tadpoles is about 35mm. They are deep-bodied, ovoid with a well rounded snout. The eyes are positioned dorsolaterally. The dorsal surface is dark brown to yellow brown, darkest over the braincase and intestinal mass. The tail is twice as long as the body, and the musculature is light brown in colour with irregular markings. The fins are transparent with irregular dark markings. (Tyler and Anstis 1975, E. Meyer unpublished data).

Habitat

Lives along streams in upland areas (altitude range of 500-1400m) in a range of habitats, usually associated with dense overhanging vegetation. Populations usually inhabit streams that are slow-flowing, with sections of permanent pools, and surrounded by dry and wet sclerophyll forest, rainforest, montane forest and heathland. Also recorded from areas disturbed by grazing. (Anstis and Littlejohn 1996, Gillespie and Hines 1999).

Distribution
Known from the eastern fall of the Great Divide from The Flags south of Walcha, New South Wales (approximately 31° 20´S, 151° 32´E), to Girraween National Park near Stanthorpe, Queensland (28° 40´20″S, 151° 40´30″E) (Figure 7) (Gillespie and Hines 1999, Mahony *et al.* 2001).

Current distribution
Knowledge of the historical distribution of *L. subglandulosa* is limited. Prior to 1975, it was known only from three localities (Tyler and Anstis 1975), and few other localities were reported until the 1990s (Anstis and Littlejohn 1996). Consequently, there is a limited historical base for assessment of population declines and indicates the need for comprehensive studies to determine population trends across the distribution of the species*. Litoria subglandulosa* may have disappeared or suffered a drastic decline in three streams near Point Lookout (Anstis and Littlejohn 1996, Anstis 1997) and other streams that originate from the New England Tablelands (Mahony *et al.* 2001). It also appears that *L. subglandulosa* has disappeared from a stream in Girraween National Park in Queensland, although it is now known from other streams in the park (QPWS unpublished data).

Threats
There are several potential causes of population declines of *L. subglandulosa*, including modification of the riparian zone due to forestry, agricultural and grazing activities. Introduced trout also occur in several streams where this species has declined, and may be preying on its tadpoles. (Gillespie and Hines 1999, Mahony *et al.* 2001)

Conservation status
Most assessments of the conservation status of this taxon were made prior to it being split into two species by Mahony *et al.* (2001). *Litoria subglandulosa sensu lato* is currently listed as Vulnerable in Queensland, Insufficiently Known in the Action Plan, but is not listed nationally. It meets IUCN (2001) criteria for Near Threatened.

Mahony *et al.* (2001) assessed the status of *Litoria subglandulosa sensu stricto* and categorised it as vulnerable. In Queensland it is known only from Girraween National Park.

Figure 1. *Distribution of Fleay's barred-frog Mixophyes fleayi.*

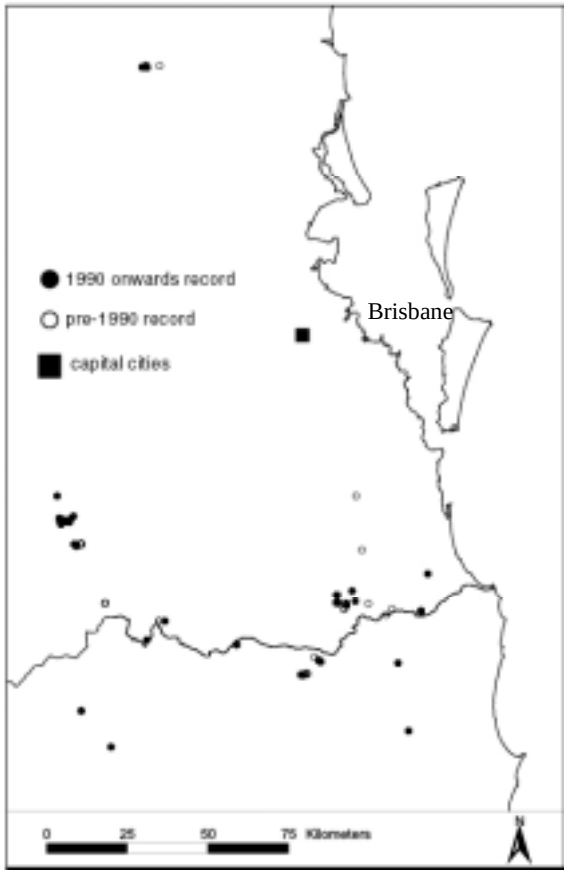

Figure 2. *Distribution of giant barred-frog Mixophyes iteratus.*

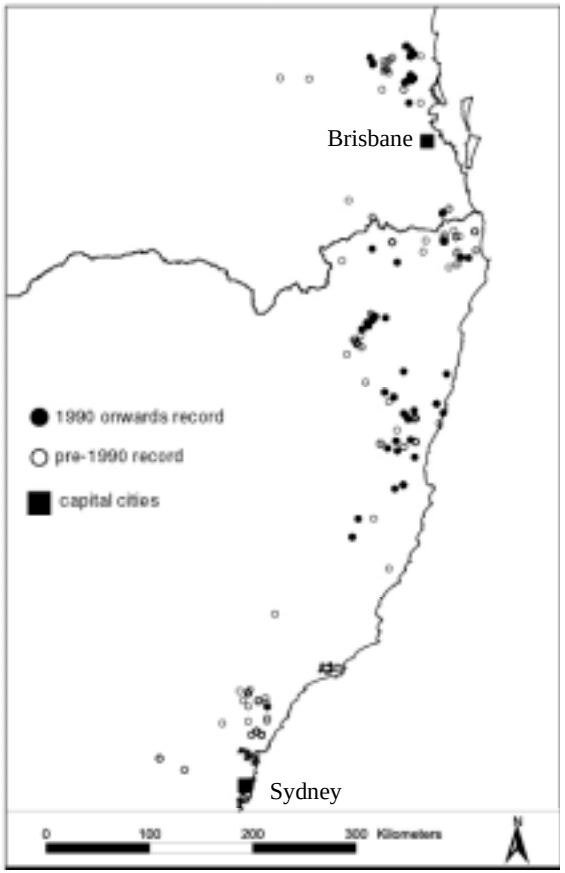

Figure 3. *Distribution of southern gastric-brooding frog Rheobatrachus silus.*

Shaded areas are: light grey - State forest or timber reserve, dark grey - national parks and conservation parks. Some towns and larger streams are shown.

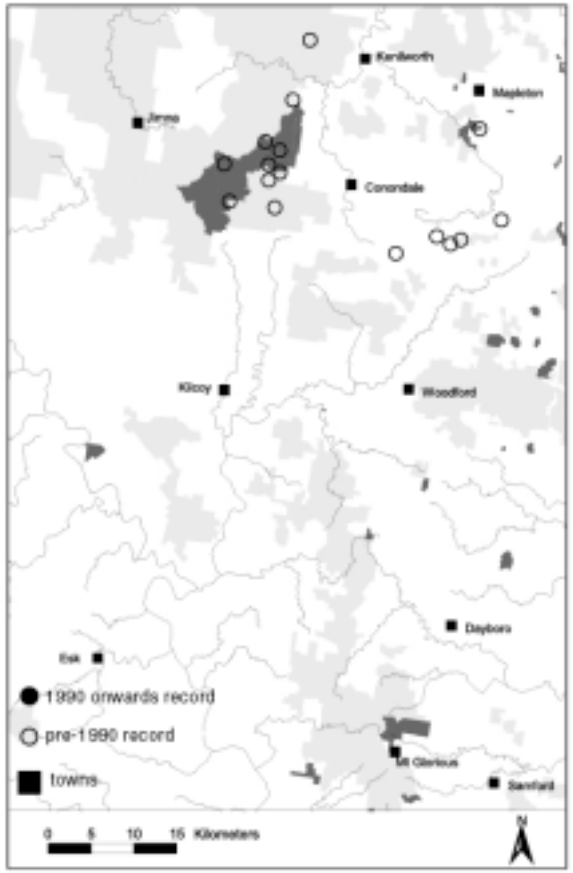

Figure 4. *Distribution of southern dayfrog Taudactylus diurnus.*

Shaded areas are: light grey - State forest or timber reserve, dark grey - national parks and conservation parks. Some towns and larger streams are shown.

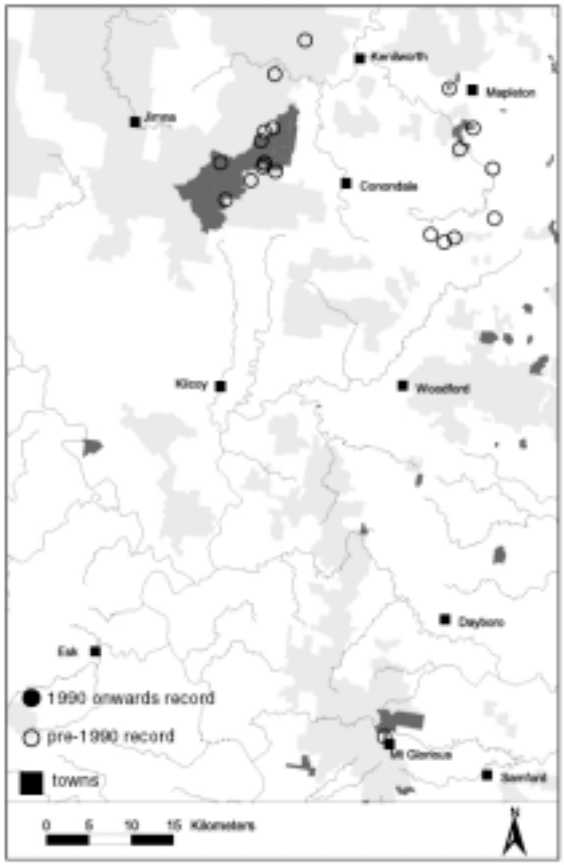

Figure 5. *Distribution of Kroombit tinkerfrog Taudactylus pleione and Kroombit Tops population of Litoria pearsoniana*.

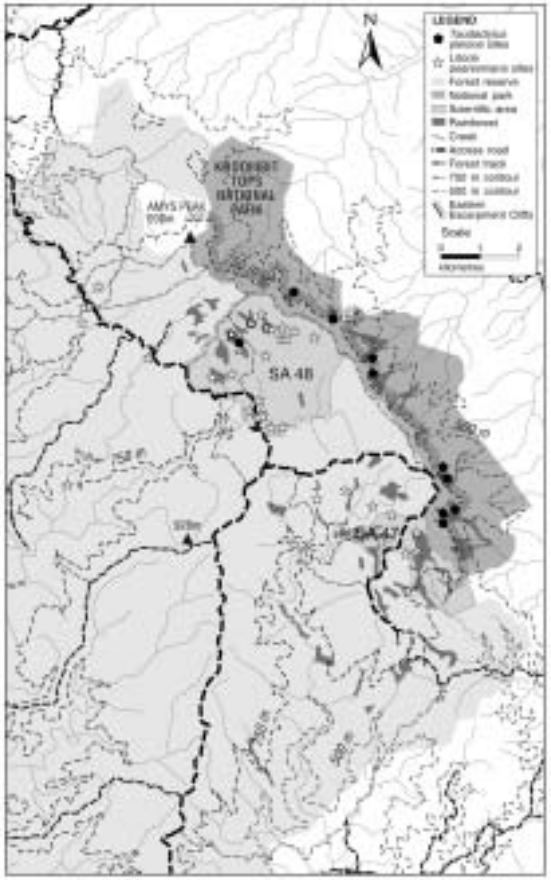

Figure 6. *Distribution of cascade treefrog Litoria pearsoniana.*

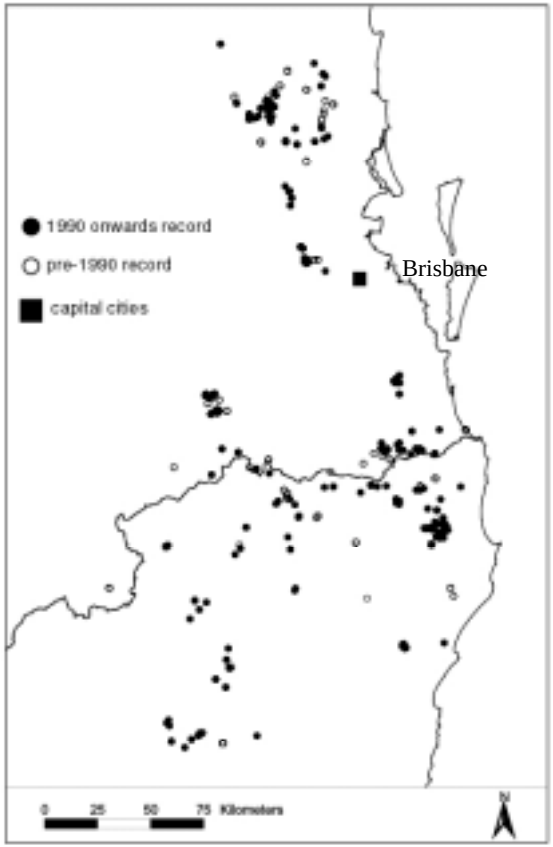

Figure 7. *Distribution of New England treefrog Litoria subglandulosa sensu stricto*.