DEVELOPING MANAGEMENT STRATEGIES TO CONTROL AMPHIBIAN DISEASES:

DECREASING THE RISKS DUE TO COMMUNICABLE DISEASES

REPORT TO ENVIRONMENT AUSTRALIA

30 January 2001

Rick Speare and
Steering Committee of Getting the Jump on Amphibian Disease

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EXECUTIVE SUMMARY

This document fulfils the scope items for a contract between Environment Australia and Rick Speare of James Cook University to run a Conference / Workshop to develop management strategies to lessen the risk of communicable diseases to wild amphibians.

The event was held in Cairns on 26-30 August and consisted of 5 components: a scientific conference on serious communicable diseases of amphibians, a workshop to develop strategies to lessen the risks of these diseases to wild amphibians, a public forum to disseminate ideas to and receive ideas from the general public, a meeting of a core working group to prioritise recommendations, and a World Wide Web site to disseminate information and to allow two-way exchange of ideas on strategies to lessen risks.

The tangible outputs from this contract are: a Conference / Workshop *(Getting the Jump! on Amphibian Disease*) that attracted participants locally, nationally and internationally, a set of recommendations proposing strategies to lessen the risks of communicable diseases to wild amphibians, protocols for quarantine of amphibians moving between nations, quarantine protocols to be used in zoological institutions, web page (http://www.jcu.edu.au/school/phtm/PHTM/frogs/gjoad.htm) containing the above data and allowing input to recommendations, and nomination of amphibian chytridiomycosis as a key threatening process. Intangible products include development of a national network of multidisciplinary scientists and wildlife managers with a common understanding of the significant communicable disease threats to wild amphibians, and a premptive place globally for Australian efforts in managing diseases of wild amphibians.

The focus of this document is on formidable infectious diseases of wild amphibians. These are diseases with the potential to cause high levels of illness and death in wild populations. Two diseases, chytridiomycosis and ranaviral disease, were identified as being formidable diseases based on their pathogenicity and potential to cause epidemic deaths. Chytridiomycosis, caused by the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, was identified as the disease of greatest threat to wild amphibians. The evidence that *B. dendrobatidis* can cause significant population declines is convincing. The majority of the recommendations generated during the Workshop deal with strategies to lessen the risks of the amphibian chytrid fungus at the local, regional, national and international levels. Ranaviral disease is also capable of causing high levels of mortality in wild amphibians. Although ranaviral disease has played a significant role in the decline of local populations in USA, the role of ranaviruses in Australian amphibian declines is unclear. The recommendations from the Workshop also deal with ranaviruses, but with less of an emphasis from the Australian perspective.

This document is a valuable resource to assist us in developing and implementing strategies to manage communicable diseases capable of putting at risk populations of amphibians in the wild.

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1. BACKGROUND TO THIS REPORT

The cause of frog declines in seemingly pristine environments over the last two decades in Australia and Central America has been an enduring mystery with dire consequences for conservation. In Australia, at least seven species have declined to the point of extinction, while many other formerly common species are now listed as Vulnerable or Endangered.

Since the late 1980s various researchers have mooted the possibility that infectious disease of an unspecified kind has played a significant role in frog declines in tropical Queensland. More recently, several potential pathogens have been identified, most notably the chytrid fungus *Batrachochytrium dendrobatidis* which has been confirmed as a proximate cause of frog mortality in wild populations. Today, outbreaks of chytrid disease are recorded from Australia in three zones including much of the east, the southwestern corner, and Adelaide and its environs, and from other countries including New Zealand, Central America, South America, USA, and Spain.

Few researchers would now doubt that emerging infectious diseases such as chytridiomycosis pose a significant threat to the survival of many species of Australian frogs. Under a precautionary approach, it is thus timely to consider options for effective disease control and to formulate appropriate management and community actions. To this end, we decided to hold a conference/workshop on the causes of frog declines in Australia, with special emphasis on management and community strategies to lessen the impact of infectious diseases.

A proposal was developed by Rick Speare to organise a conference and workshop on strategies to lessen the risk of communicable diseases to wild amphibians. This concept arose from a meeting initiated by Keith McDonald and held at James Cook University in 1999 to develop strategies to control amphibian declines due to communicable disease.

Funding to support the proposal was obtained from the National Heritage Trust (NHT) and World Wide Fund for Nature Australia (WWF). Academic organisations, particularly James Cook University, and government bodies, notably Queensland Parks and Wildlife and Environment Australia, contributed significantly through input of staff time and access to resources.

The aims of the original proposal were:

- to provide a multidisciplinary summary of current knowledge of infectious diseases implicated in the decline of Australian frogs
- to establish mechanisms for communication between research groups involved in the study of frog diseases
- to explore options for community and governmental action in the prevention of, and recovery from, disease outbreaks
- to encourage formation of partnerships between research groups, government agencies and community groups for the development of effective disease management strategies

2. PURPOSE OF THIS DOCUMENT

This document fulfils three purposes:

1. It is the official report to Environment Australia fulfilling the scope items of the NHT contract;
2. It is the official report to World Wide Fund for Nature Australia for their financial support for the Conference / Workshop;
3. It is a means of disseminating the data and recommendations generated from the Conference / Workshop.

3. SCOPE ITEMS IN NATIONAL HERITAGE TRUST CONTRACT

Scope Item 1: Implement actions in accordance with approved project application.

Scope Item 2: Complete one conference on Causes of Amphibian Declines and their Management by **ANNUAL REPORT**.

Scope Item 3: Submit results and recommendations of "Causes of Amphibian Declines and their Management**"** Conference by **ANNUAL REPORT**. Reports should clearly show how results relate to Frog Action Plan recommendations and set out any recommendations that will assist agencies and others to adjust activities and priorities in relation to abating the perceived threat(s) to amphibian conservation.

Scope Item 4: If warranted and required, complete and submit a nomination for listing of Chytrid fungus suitable for assessment by the Endangered Species Advisory Committee (or the Threatened Species Scientific Committee if submitted after July 16) by **ANNUAL REPORT**.

4. SCOPE ITEM 1: Implement actions in accordance with approved project application

To implement actions a Steering Committee was formed with Rick Speare of James Cook University as chair and Kerry Moore of the Rainforest CRC as co-ordinator. Composition of Steering Committee is given in Attachment 1. To achieve the aim of basing recommendations for management on the best available evidence, the Steering Committee chose a sophisticated format that consisted of 5 components:

- Scientific conference to disseminate the most up to date data on amphibian diseases and the management strategies used so far to lessen risks of these diseases
- Workshop to develop recommendations based on best available evidence
- Public forum to communicate with public
- Core working group to refine recommendations and to address listing as a key threatening process.

- Web pages to disseminate information more widely and to allow comment prior to submission of Annual Report.

Sponsorship of $20,000 was received, $10,000 from National Heritage Trust via Environment Australia and $10,000 from World Wide Fund for Nature, Australia. This funding was used to initiate the event, to support management of the event by the Rainforest CRC, to secure the venue in Cairns, to pay for some secretarial assistance to the Chair of the Steering Committee, to reduce costs of the 4 day event to participants, and to pay for travel and accommodation costs of two amphibian disease experts from USA. Registrants, including other speakers, were expected to find funds for their own attendance and the registration fee of $290.

5. SCOPE ITEM 2: Complete one conference on Causes of Amphibian Declines and their Management

The event was held in Cairns from 26-30 August under the name *Getting the Jump! on Amphibian Disease*. The scientific conference, the workshop and the public forum were held at the Radisson Plaza Hotel in Cairns, and the core working group met formally at the Cairns Campus of James Cook University.

5.1 Scientific Conference

The scientific conference was held on Saturday 26 and Sunday 27 August from 09:00 to 21:30 each day (Table 1). Rick Speare was the convenor for the scientific conference. The program of the scientific conference and abstracts are in the Compendium of Getting the Jump! on Amphibian Disease (Attachment 2). Program, abstracts and some full presentations are available online at http://www.jcu.edu.au/school/phtm/PHTM/frogs/gjoad.htm.

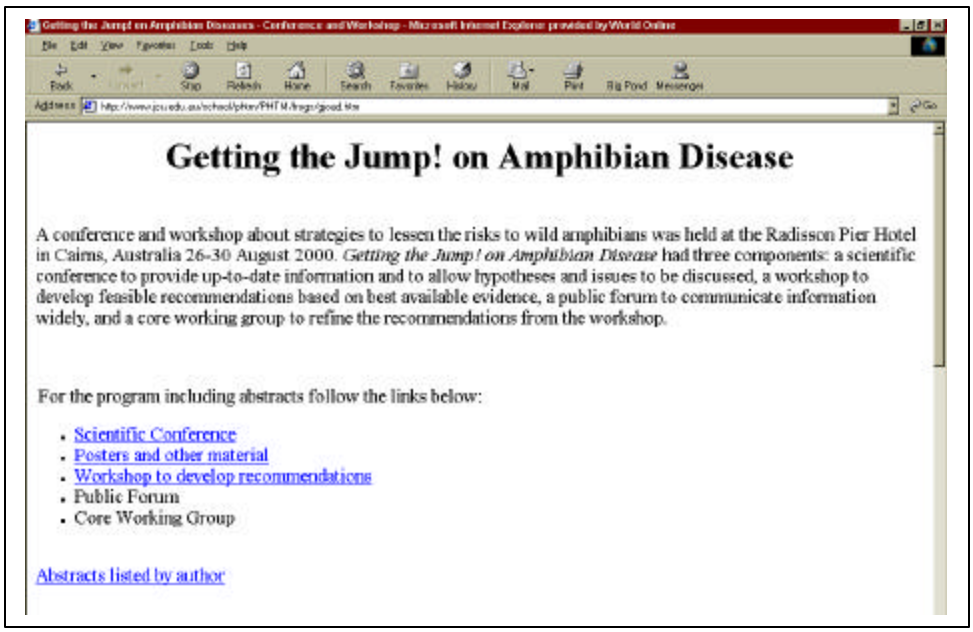

Figure 1: Stan Orchard, Director of Frogs Australia! for World Wide Fund for Nature Australia discusses strategies with Professor Tim Halliday, International Director of the Declining Amphibian Population Task Force.

Figure 2: Deborah Pergolotti was an active participant at Getting the Jump! on Amphibian Disease. Deborah runs the community based Cairns Frog Hospital which plays an active role in disease research in North Queensland. Deborah also proposed the name for the Conference / Workshop, winning the competition to name the event. Her WWW site (http:www.fdrproject.org) has accurate and useful information about amphibian diseases and disseminates information to community members who retrieve and care for ill frogs.

Table 1: Program for scientific conference at Getting the Jump! On Amphibian Disease 26-27 August 2000.

Saturday 26 August

Event	Duration	Speaker	Title
Registration	8:00-9:00		
First Session: Opening and plenary papers Chair: Stan Orchard	9:00-9:15	Nigel Stork	Opens conference
	9:15-9:35	Tim Halliday	Amphibian population declines: Putting disease in perspective
	9:35-9:55	Rick Speare	Understanding the pieces of the amphibian disease puzzle
	9:55-10:15	Ross Alford	Testing the novel pathogen hypothesis
Morning break	10:15-10:30		
Second session: Amphibian chytrid Chair: Harry Hines	10:30-11:00	Joyce Longcore	*Batrachochytrium dendrobatidis,* the "frog chytrid"
	11:00-11:30	Lee Berger et al	Overview of Batrachochytrium and frog declines
	11:30-11:55	Elizabeth Davidson et al	Chytridiomycosis in Arizona (USA) Tiger Salamanders
	11:55-12:30	Ken Aplin, Peter Kirkpatrick	Chytridiomycosis in southwest Australia: historical sampling documents the date of introduction, rates of spread and seasonal epidemiology, and sheds new light on chytrid ecology
Lunch	12:30-13:30		
Third Session: Laboratory and husbandry aspects Chair: Michael Lynch	13:30-13:45	Alex Hyatt et al	Advances in the development of diagnostic assays for the detection of the amphibian chytrid fungus (Genus *Batrachochytrium*)
	13:45-14:00	Gerry Marantelli, Lee Berger	Quarantine methods for captive collections
	14:00-14:15	Gerry Marantelli**,** Lee Berger, Kelly McInnes	Investigations into the treatment of *Batrachochytrium* in frogs and tadpoles
	14:15-14:30	Gerry Marantelli	Providing tools for research and the building of arks: the role of husbandry in disease research and recovery processes
Afternoon break	14:30-15:00		
Fourth session: Ranaviruses Chair: Rod Pietsch	15:00-15:45	Alex Hyatt, Andrew Cunningham	Ranaviruses; a threat to amphibians?
	15:45-16:15	Brad Cullen, Lee Owens	Ranaviruses in amphibians
	16:15-16:45	Leigh Owens, Brad Cullen	The potential role of hobby and pest fish in spreading systemic iridoviruses
	16:45-17:00	Jim Collins et al	The current status of salamander ranaviruses in Western North America
Fifth session: Synthesis of main points	17:00-17:15		Overview of main points
Night Session	19:00-22:00	Histological diagnosis of chytridiomycosis	Lee Berger, Diana Mendez, Rick Speare

Figure 3: Participants at the workshop. In the front row are Ross Alford, James Cook University (left) and Jim Collins, Arizona State University (right). Betty Davidson, Arizona State University is directly behind Jim and Joyce Longcore, University of Maine, is to her left. Ross Alford is a member of the Core Working Group.

Sunday 27 August

Event	Duration	Speaker	Title
First Session: International outbreaks Chair: Jim Collins	09:00-09:20	Jean-Marc Hero et al	The ecological characteristics of declining frogs in Australia: implications for global amphibian declines.
	09:20-09:40	Jaime Bosch	Evidence of a chytrid fungus infection involved in the decline of the common midwife toad in protected areas of Central Spain
	09:40-10:00	Rolando Mazzoni	Diseases in farmed American bull frog *(Rana catesbeiana* Shaw, 1802) in Uruguay
	10:00 -10:20	Bruce Waldman et al	Discovery of chytridiomycosis in New Zealand
Morning break	10:30-11:00		
Second Session: Epidemiological aspects Chair: Julia Playford	11:00-11:30	Peter Daszak et al	Amphibian chytridiomycosis, emerging diseases and pathogen pollution
	11:30-12:00	Richard Retallick, Lisa Dwyer	Using translocations to learn about frog declines and disease
	12:00-12:30	Hamish McCallum	Epidemiological modelling of amphibian disease

Lunch	12:30-13:30		
Third session: Surveillance Chair: Liz Dovey	13:30-14:00	Rick Speare	Surveillance of amphibian populations for infectious diseases
	14:00-14:30	Michael Mahoney	Prevalence of chytrid in wild populations of frogs in eastern New South Wales
	14:30-15:00	Grahame Gillespie, Gerry Marantelli	The role of the amphibian chytriomycete fungus in population dynamics of the spotted tree frog (*Litoria spenceri*) a declining riverine species in south-eastern Australia
Afternoon break	15:00-15:30		
Fourth session: Community and corporate involvement Chair: Keith McDonald	15:30-15:50	Stan Orchard	Are corporate partnerships the future and salvation of amphibian conservation biology research?
	15:50-16:10	Ken Aplin, Suzanne Johnson	Community involvement in the detection, surveillance and management of frog diseases: a case study from Alcoa frogWAtch, southwest Australia
	16:10-16:30	Jenny Holdway et al	The role of the Queensland Frog Society in the prevention of potentially fatal amphibian diseases in frog populations.
	16:30-16:50	Gerry Marantelli, Raelene Hobbs	Disease vectors and the community: from lost frogs to frog friendly gardens – how do we help frogs while containing disease spread?
Fifth Session: Overview of the day	16:50-17:15		Overview of day's main points
Night session	19:00 - 22:00	Workshop on culturing chytrids: Recognising, isolating, and culturing *Batrachochytrium dendrobatidis* From amphibians	Joyce Longcore, Lee Berger

Figure 4: Rod Pietsch is a Project Officer in Southern Directorate Threatened Species Unit, New South Wales National Parks and Wildlife Service.

5.2 Workshop to Develop Feasible Recommendations

The workshop component followed immediately after the scientific conference at the same venue. It was held on Monday 28 and Tuesday 29 August from 09:00 to 17:00 each day (Table 2). Most of the attendees at the scientific conference also attended the workshop. Keith McDonald (Queensland Environmental Protection Agency) convened the workshop; Liz Dovey (Environment Australia) was the workshop facilitator. Rapettoirs at the workshop were Harry Hines (Queensland Environmental Protection Agency) and Megan Johnson (School of Public Health and Tropical Medicine, James Cook University). The program and some abstracts are in the Compendium of Getting the Jump! On Amphibian Disease (Attachment 2). Recommendations are included in Attachment 3.

Figure 5: Keith McDonald, Chief Ranger with Queensland Parks and Wildlife, with Bill Freeland, Director of Parks and Wildlife Commission of Northern Territory. Keith was a convenor of the Workshop, and a member of the Core Working Group. Bill was a key speaker and active participant in the Workshop.

Figure 6: Nick Shephard, Threatened Species Unit, Northern Directorate, New South Wales, National Parks and Wildlife Service.

Figure 7: Megan Johnson, James Cook University, assisted with recording and collating discussion and recommendations from the Workshop.

Table 2: Program for workshop at Getting the Jump! On Amphibian Disease 28-29 August 2000.

Monday 28 August

Registration	8:00-8:45	Registration of "new" people	
Opening session: Aims & Overviews	8:45-9:00	Aims of workshop	Liz Dovey
	9:00-9:45	Overview and update of significant diseases of wild amphibians	Rick Speare
	9:45-10:30	Regulation, policy and the conservation of wildlife	Bill Freeland
Morning break	10:30-11:00		
2nd Session International issues	11:00-12:00	Questions to address on international issues 1. Do pathogens get carried between countries? 2. Is this a risk to wild amphibians in importing countries? 3. How large a risk? 4. Is the risk different for different pathogens? 5. What surveillance is needed? 4. What feasible strategies are available to lessen the risk?	
		DAPTF International strategies	Tim Halliday
		Quarantine - Australian perspective	Jonathan Lee
Lunch	12:00-13:00		
3rd session National issues	13:00-15:00	Questions to address on national issues 1. Do pathogens get moved around countries? 2. How significant a risk is this? 3. What are the risky activities? 4. Are there zones within countries that are free of particular pathogens? 5. What surveillance is needed to quantify risks? 6. What feasible strategies can be used to lessen the risks? 7. What can be done to contain newly arrived pathogens?	
		New Zealand outbreak	Bruce Waldman
		Europe	Jaime Bosch
		Uruguay	Rolando Mazzoni
Afternoon break	15:00-15:30		

4th Session Regional issues - agricultural produce & pet trade - risks	15:30-16:15	Question to address on regional issues: Amphibians accidentally moved in produce 1. Can the risk due to banana box frogs be decreased at source? 2. Can the risk due to banana box frogs be decreased after arrival? 3. How can the risk be monitored? Amphibians moved in the pet trade 1. Is there a risk due to the pet trade in amphibians? 2. Can the risk be decreased at source? 3. Can the risk be decreased before sale? 4. How can the risk be monitored?	
		Banana industry	Morrie
		Management of frogs in produce / pet trade	Gerry Marantelli
Agricultural produce & pet trade - strategies	16:15-17:00	Questions to address on regional issues: 5. Will treatment decrease the risk? 4. What feasible strategies are available to decrease the risks of amphibians in produce? 5. What feasible strategies are available to decrease the risks of amphibians in the pet trade? 6. Should all commercial suppliers of amphibians for pet trade be accredited?	
Fifth Session: Synthesis	17:00-17:30		

Figure 8: Jamie Bosch (Spain) and Rolando Mazzoni (Uruguay) were the Spanish-speaking contingent of delegates from overseas. Overseas participants came from New Zealand, USA, Germany, UK, Spain and Uruguay.

Tuesday 29 August

First session: Labs & amphibian husbandry	09:00-09:45	Questions to address about laboratories 1. Are labs with pathogens a risk to wild amphibians? 2. How much a risk are pathogens in labs? 3. What procedures can be used to remove this risk? 4. Should use of amphibian pathogens by labs be restricted?	
		Lab procedures to minimise risk	Lee Berger & Alex Hyatt
	9:45-10:30	Questions to address about amphibian husbandry 1. Are amphibians raised / kept in captivity a risk to wild populations? 2. How can risks of pathogens transmitting within husbandry facilities be reduced? 3. What surveillance strategies should husbandry facilities use to monitor pathogens? 4. How can risks of pathogens being moved to wild populations be decreased? 5. Should there be minimum standards and accreditation for husbandry facilities? 6. What protocols and monitoring should be done on amphibians released from husbandry facilities?	
		Procedures to lessen risks in husbandry	Gerry Marantelli
Morning break	10:30-11:00		
Second session: Field research	11:00-12:30	Questions to address on field research: 1. What strategies will reduce the risks of pathogens being transmitted between frogs in the same waterbody during ecological monitoring? 2. What strategies will reduce the risks of pathogens being transmitted between waterbodies? 3. How can the risk due to equipment that contacts frogs be reduced? 4. How can the risk due to garments and gear be reduced?	
		Protocols to lessen risks in field research	Harry Hines
Lunch	12:30-13:30		
Third session: Education / information	13:30-14:30	Questions to address on education and information Which groups need to be educated on risks and how to reduce them? What do they need to be told? What is the best way to provide this information?	
		Education	Ken Aplin
Afternoon break	14:30-15:00		

Fourth Session: Role of the Community	15:00-16:30	Questions to address on role of community 1. What role can the community play in surveillance for amphibian diseases? 2. What role can the community play in lessening risks of transmitting pathogens? 3. What role can the community play in assisting amphibian populations to survive?	
		Role of the community	Ken Aplin
Fifth Session: Key threatening process	16:30-17:00	Should amphibian chytridiomycosis be proposed to Environment Australia as a key threatening process?	
Close	17:00-17:10	Close of workshop	Keith McDonald

Figure 9: Harry Hines, Queensland Parks and Wildlife, Brisbane, in intense discussion with Jenny Holdway, President of Queensland Frog Society. Harry also played a key role in the Workshop by recording minutes and collating discussion points.

5.3 Public Forum

The public forum, "Solutions for a Frog Friendly Planet", was held on Tuesday 29 August at the Radisson, Cairns, from 17:00-19:00. This was chaired by Kerry Moore (Fig. 11) of the Rainforest CRC and included 6 speakers from the conference plus many of the registrants as members of the audience (Table 3).

Table 3: Speakers at Solutions for a Frog Friendly Planet.

Kerry Moore	Chair
Gerry Marantelli	Amphibian Research Centre, Melbourne
Liz Dovey	Environment Australia
Harry Hines	Queensland Environmental Protection Agency
Jenny Holdway	Queensland Frog Society
Stan Orchard	World Wide Fund for Nature, Australia
Ken Aplin	Alcoa FrogWAtch
Deborah Pergolotti	Cairns Frog Hospital

Figure 10: The public forum attracted children as well as adults. Two "froggy" kids getting into the spirit!

The public forum was well attended by the public with an estimated 100 people in addition to registrants. At least half of the time was spent on interaction between the public and the speakers, a lively question, answer and comments segment.

Figure 11: The public forum, Solutions for a Frog Friendly Planet, was well attended by the public and by participants from the Workshop.

5.4 Core Working Group

The core working group (Fig. 12) met from 09:00 to 15:00 on Wednesday 30 August at the Rainforest CRC, Cairns campus of James Cook University to refine and prioritise recommendations from the Workshop and to decide whether chytridiomycosis should be proposed as a key threatening process. The meeting was chaired by Rick Speare (James Cook University) and included Liz Dovey (Environment Australia), Keith McDonald and Harry Hines (Queensland Parks and Wildlife), Stan Orchard (World Wide Fund for Nature, Australia), Ross Alford, Leigh Owens and Brad Cullen (James Cook University), Lee Berger (Australian Animal Health Laboratory and James Cook University), Gerry Marantelli (Amphibian Research Centre), Tim Halliday (Declining Amphibian Task Force - International), and Ken Aplin (Alcoa FrogWAtch and Western Australian Museum) and Michael Lynch (Melbourne Zoo). Recommendations refined and prioritised by the Group are available in Attachment 5. Quarantine protocols developed in line with priorities are given in Attachment 6.

Figure 12: Members of the Core Working Group.

Lee Berger and Rick Speare

Leigh Owens

Ken Aplin

Gerry Marantelli (left) with Ross Alford

Stan Orchard

Keith McDonald

Tim Halliday

Harry Hines

Brad Cullen

Liz Dovey

Michael Lynch

Kerry Moore

5.5 Web Pages to Communicate Data and Recommendations

The WWW was an important means of informing people of the conference and its goals. A conference web site was established at the Rainforest CRC site - http://www.rainforest-crc.jcu.edu.au/amphibian.asp. People were able to register online. Just before the event, the program and abstracts for the scientific conference were put on line at http://www.jcu.edu.au/school/phtm/PHTM/frogs/gjoad.htm. After the event, other material was made available including the Workshop program and recommendations from the Workshop, the summary of formidable infectious diseases of amphibians, quarantine protocols, and some complete presentations from the Conference. All this material can be accessed at http://www.jcu.edu.au/school/phtm/PHTM/frogs/gjoad.htm.

5.6 Media Interest

Rainforest CRC conducted a professional public relations campaign to make people aware of the Conference/Workshop. Both the scientific and lay media channels were used to promote the event. Initially this was to attract participants, and just prior to the event the media was used very successfully to disseminate the concepts being discussed in the Conference/Workshop, and at the Public Forum. A great deal of media interest was shown by print (local, national and international newspapers and scientific journals), television (local and national), and radio (local and national). A selection of media reports is given in Attachment 3.

6. SCOPE ITEM 3: Submit results and recommendations of Conference / Workshop by annual report

Reports should clearly show how results relate to Frog Action Plan recommendations and set out any recommendations that will assist agencies and others to adjust activities and priorities in relation to abating the perceived threat(s) to amphibian conservation

6.1 Results and Recommendations

Recommendations were generated by participants in the Workshop. These were prioritised by the Core Working Group on the day following the Workshop (30 August 2000). They were then put into a more formal style by Rick Speare and posted on the WWW at the address given in Section 5.5. Modifications were made in response to suggestions received by email. A second draft of the recommendations was posted one week later. All participants were contacted by email and asked to comment. A message was also posted on Frognet. Special comment was sought and obtained from the banana industry. Comment on the second

draft was accepted for 6 weeks. Care was taken not to change the essence of the recommendations as developed at the Workshop. The final recommendations are presented in Attachment 5.

6.2 How Conference/Workshop met recommendations from the Action Plan for Australian Frogs

Action Plan Recommendation 1: That high priority be given to research and management actions to address frog declines.

Research and reporting on diseases in amphibians has identified specific diseases associated with population declines (see Attachment 4), in particular chytridiomycosis. The current state of knowledge and current hypotheses about disease as causes of declines were discussed in detail at the conference and workshop. A number of hypotheses have been generated on the role of disease in declines and testing of some of these are well under way. Protocols and strategies to lessen the risk of infectious agents on amphibian populations were identified. Questions for research to provide better data for management decisions were prioritised.

Action Plan Recommendation 3: That research and analysis be undertaken to clarify the possible contributing role of factors, including data already available from Australian and international studies.

Information provided at the conference demonstrated that several amphibian diseases can cause significant morbidity and mortality in amphibian populations. In Australia the amphibian chytrid fungus has been shown to be capable of killing frogs and has been associated with declines. There is also evidence to suggest that this disease has been spreading throughout Australia and is associated with frog population declines in some regions. Data from Spain, Panama, Ecuador, and New Zealand also supports the role of chytridiomycosis in mortality in amphibian populations.

Action Plan Recommendation 4: That attempts be made to determine if there are causal factors common to these declines and if any of these operate together, or even synergistically.

The work on the amphibian chytrid fungus has shown that it has caused morbidity and mortality at times of declines in at least one population of frogs in sub-alpine Australia (Spotted Treefrog at Bogong Ck) and in the Wet Tropics. Decrease in temperature appears to be a significant environmental variable that increases both infection rate and mortality rate in amphibian populations. It is not yet known whether the disease is the cause of declines in these and other areas, but monitoring and research are continuing to examine this.

Action Plan Recommendation 6: That priority be given to improve expertise in captive breeding and husbandry techniques.

Techniques for frog husbandry in Australia in have been greatly improved in recent years. At the Conference / Workshop (through papers and discussion) protocols and practices for the management of disease in husbandry and translocations/reintroductions were discussed and developed.

Action Plan Recommendation 7: That public involvement, particularly through amateur associations, be encouraged and incorporated into conservation assessment and recovery planning.

The Conference / Workshop was attended by a diverse audience from many parts of the world, including representatives from natural history and frog community groups, rural community and industry, veterinarians, academics, and conservation managers. The findings of the conference and workshops were presented at a public forum and will be available on the Amphibian Diseases website (http://www.jcu.edu.au/school/phtm/PHTM/frogs/gjoad.htm). Community volunteers have assisted greatly in monitoring diseases in amphibians.

Action Plan Recommendation 9: That a national working group for frog conservation be established to facilitate regular communication between frog experts. This group should link to the DAPTF as appropriate.

Members of the National Threatened Frogs Working group and the International Declining Amphibians Population Task Force (DAPTF) were present at the conference and workshops. Mechanisms for maintaining collaboration and consistency of data at the international and national level were recommended.

7. SCOPE ITEM 4: If warranted and required, complete and submit a nomination for listing of Chytrid fungus suitable for assessment by the Endangered Species Advisory Committee (or the Threatened Species Scientific Committee if submitted after July 16) by annual report.

A nomination titled "Disease in amphibians caused by the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*" was prepared in consultation with the Steering Committee and was submitted to the Threatened Species Scientific Committee in December. This is included in Attachment 7.