



THREATENED FROGS OF
Madagascar

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Realised within the framework of *A Conservation Strategy for the Amphibians of Madagascar and Amphibian Specialist Group / IUCN*

Front cover: *Mantella expectata* from the Isalo Massif

Back cover: *Spinomantis phantasticus* from the Anjanaharibe-Sud Massif

Foreword

Our intention is to provide some basic information on the conservation of the highly diverse and threatened amphibians of Madagascar. With more than 235 species of frogs found only in Madagascar, the island is one of the richest “froggy” places in the world. The frogs of Madagascar, however, suffer from a series of threats, including habitat alteration, deforestation, pollution and collection for the pet-trade. Therefore, in September 2006 a symposium specifically dedicated to the conservation of the Malagasy amphibians was held in Antananarivo, Madagascar. The ACSAM (A Conservation Strategy for the Amphibians of Madagascar) identified several essential measures necessary for promoting the conservation

of Malagasy frogs. Among these, education and public awareness play an important role.

This booklet, aimed at a wide audience and written in different languages, is intended to show the beauty and importance of these animals, the amphibians, that are disappearing all around the world and are one of the most endangered vertebrates. It is not intended to be an identification manual or a scientific book, although it has been written in a scientific way. We hope that looking at its beautiful photographs the reader will fall in love with the Malagasy frogs, and will help us in their protection.

Madagascar

The island of Madagascar lies 400km off the east coast of Africa and has been separated from the mainland for at least 165 million years. Because Madagascar has been isolated for so long many of the island's plants and animals are unique and are found nowhere else on Earth. Madagascar was once cloaked in forest. Now only

about 10% of the original forest remains. Almost half of this is dense humid rainforest found along the east coast. The south of the island is much drier; here spiny desert dominates the landscape, while the west is home to fragmented dry evergreen forests and vast savannah plains.



The most famous animals found only in Madagascar are the lemurs. At present more than 90 species of lemur live in Madagascar, but in the past there were many more different kinds, including a giant ground living lemur which is thought to have been the same size as a gorilla. Other extinct species include the elephant bird, which laid the largest egg of any bird, living or extinct.

Today the island is also famous for its endemic frogs, chameleons, geckos and tortoises. The biggest chameleon in the world lives on Madagascar, alongside the smallest species. 99% of Malagasy frogs are endemic and 95% of the island's plants are found nowhere else.

The first people to arrive on Madagascar came from Indonesia and Malaysia about 2000 years ago followed by Arabs and Polynesians. Europeans first landed there in the 1500s. Now there are estimated to be 18.4 million people living on the island.



◀◀ The famous "baobab road" next to Morondava, W-Madagascar. Baobab represent one among the peculiar biodiversity offshoots of Madagascar, with seven endemic species.

▲ Black and white ruffed lemur, *Varecia variegata*. Lemurs are undoubtedly the most known animals of Madagascar and main touristic attraction.



Sadly most Malagasy people live in poverty, especially in rural areas. Education is expensive and, though a third of children are privately schooled, one third receive no education at all and only 45% of adults can read and write.

Increasingly large areas of rainforest are being converted into agricultural or grazing land to provide food for a growing human population and to grow crops like vanilla and coffee for export. Such conversion leads to loss of rainforest habitat and is already

contributing to the loss of Madagascar's special wildlife. Much of the wood from rainforest trees is used as building material or as fire wood by people too poor to buy less environmentally damaging alternatives. Poverty is one of the driving forces behind destructive deforestation.

If the issue of poverty can be solved we have a much better chance of preserving, and conserving, ecologically important areas like the rainforests of Madagascar.

▶▶ An arboreal treefrog, *Boophis luteus*, mating.

▶ In Madagascar there are 18 ethnies or "karazana", originating from several immigration events from Africa and Indonesia started around 2000 years ago.





Amazing diversity

Madagascar has always been an important place for frogs. The earliest known ancestor of frogs and toads appeared around 230 million years ago in what now is Madagascar. There are more than 6,190 species of frogs worldwide, 4% of which live

in Madagascar (more than 235 described species). Scientists expect this number to rise as more species are found. The diversity of Malagasy frogs is truly incredible with combinations of bright warning colours, camouflage, skin texture, shapes and sizes.



● *Spinomantis aglavei*
from Ranomafana
National Park.



Frogs are found all over Madagascar in various habitats, but the vast majority of species can be found in the east of the country. Originally the eastern coast of Madagascar was dominated by different types of rainforest. Much of this has now disappeared, having been converted into agricultural land or being used for its valuable wood. There are still some large tracts of rainforest left in Madagascar, some of which is protected, such as the Parc National de Masoala (230,000ha). However some of the smaller areas of rainforest are home to several species of frog that are found nowhere else on the island. These small pockets of rainforest are

surrounded by farm land that is unsuitable habitat for frogs to either cross or live in. It is these isolated populations that face the greatest threat of extinction.



▲ *Boophis ankaratra*.

▲ This is a frog species described from the Ankaratra Massif, and inhabiting high altitude rainforests.

▲ *Dyscophus antongilii*. The tomato frog is one of the most known frogs of Madagascar, and object of special conservation interests, being the only frog species listed in CITES I. This means its trade is totally forbidden.



● The golden frog, *Mantella aurantiaca*, is likely the species most requested by the international pet-trade.

One of the most distinctive features of several species of Malagasy frogs is their bright colours. Many animals throughout the world use colour to advertise their distastefulness to predators, for example poison dart frogs from South America. These warning colours are referred to as aposematic. The colourful members of the family Mantellidae in Madagascar such as *Mantella aurantiaca* and *Mantella baroni* produce alkaloids in their skin; toxins which are distasteful to predators. Many scientists have suggested that the frogs gain the poison from a diet of insects such as ants, which contain alkaloids. However, some frogs don't rely on bright warning col-

ours for protection but use camouflage instead. Some Malagasy species take their camouflage to an extreme, not just having colour that matches their environment but skin that mimics lichen and plants (such as *Boophis lichenoides* and arboreal species of the genus *Spinomantis*).



▼ *Scaphiophryne gottlebei*. This species, named "rainbow frog" for its wonderful colouration, is one of the endemic frogs of the Isalo, an arid sandstone massif in southern Madagascar.

While the adult *Boophis lichenoides* is well camouflaged, the tadpole has black and yellow bands. The black and yellow bands suggest that the tadpole may secrete toxins in some way, but as the species has only recently been discovered scientists are unsure of the true use of such aposematic colours.

There are many different ways of responding to the same habitat. Many of the mantellas are terrestrial (land dwelling) and spend most of their lives on the banks of streams. Some frogs spend much of their lives climbing and living in trees (arboreal). But for each different lifestyle there are a different set of challenges – particularly for reproduction. A 'typical' frog lays eggs in water. The tadpoles emerge and develop (*metamorphose*) into froglets, which in turn become adult frogs. For frogs from tropical rainforests and from arid areas, laying eggs directly into water may not be an option. Either the eggs are eaten by predators or they dry

out, so many species vary in parts of their lifecycle. Typically species of terrestrial frogs living next to streams lay their eggs close to the water on the ground, while arboreal frogs tend to deposit their eggs on the tips or edges of leaves above

▼ The widely distributed and still abundant *Heterixalus madagascariensis* is a frog preferring open and savannah habitats, and does not penetrate the close rainforests.



water. When developed, the young tadpoles wriggle free of the egg clump and drop into the water to continue to develop into froglets.



Other arboreal species lay their eggs on leaves of plants such as *Pandanus* (screw pine); the water held in between the base of the leaves acts as a frog nursery. Alternative nursery pools can be holes in tree trunks or bamboo particularly for frogs like the climbing mantella (*Mantella laevigata*) which lays a single egg. In fact, to make sure that their tadpole has enough food to help it develop, the adult female lays 'food' eggs for the tadpole to eat during metamorphosis. Some tadpoles are carnivorous and eat insect arvae and other tadpoles. Some other tadpoles are filter feeders while others eat both plant and dead animals.

Like many other frog species globally, several Malagasy species still lay eggs directly in water or some use foam nests. The males of *Platypelis grandis* guard the eggs and even the tadpoles until the end of metamorphosis. Egg guarding is found in other frog species around the world such as *Epipedobates tricolor* from Ecuador as well as another Malagasy species, *Mantidac-*

tylus argenteus, where the male guards the eggs.

Clearly, Malagasy frogs are adapted to specific lifestyles that are dependent on the surrounding ecosystem, whether it is rainforest, swamp or deciduous forest. Habitat destruction removes breeding areas, which in turn helps deplete populations.



◀◀ Tadpoles of *Spinomantis* sp. Several mantelline frogs of Madagascar lay eggs out of the water. The egg clutch and tadpole thus develop on the ground or on the leaves. During the heavy rainfalls they drop in water where they continue the development.

▲ *Mantella expectata*. A typical anuran tadpole that develops in water.

One species, the climbing mantella (*Mantella laevigata*), lays its eggs in water filled tree hollows. This means that in order to reproduce the species must have access to several different habitats. If these habitats are separated by farmland or roads the frogs cannot reach them and therefore will be unable to breed.



Threats

▼ Rainforests of Madagascar are heavily cut to make space for ricefields, to get firewood and to obtain charcoal. This is indeed one of the most evident threats for the forest frogs that are often highly specialised and need an intact habitat.

The biggest threat to Malagasy frogs is loss of habitat, either by deforestation or through the conversion of pristine rainforest into agricultural land. Most of the Malagasy frogs live on the eastern part of the island where deforestation is particularly extensive.

Most of the habitat loss in Madagascar is driven by poverty as people convert

rainforest and other habitats to farmland in order to feed themselves and their families. Farming practices such as *tavy* (slash and burn farming) have a dramatic effect on the environment, altering habitat not only for frogs but also for Madagascar's other unique species.

Pressure on habitat such as *tavy* or logging (for building material or fuel for fires) has

a major impact on the surrounding land; often these activities break up the remaining environment leaving small fragments of suitable habitat for animals. Suitable habitats become separated and frogs find it difficult to reach their breeding places and cannot reproduce. This is particularly a problem for frogs that require different habitat for different life stages. Some species like the black and green mantella (*Mantella viridis*) are entirely terrestrial during adulthood but as tadpoles need stagnant water (*Scaphiophryne* spp.) while others can only develop in streams (*Manti-*

dactylus lugubris). Ideally the environment needs to remain intact or we must ensure that patches of suitable habitat are large enough to support healthy populations of frogs.

The more aquatic species seem to be less vulnerable to habitat conversion as they can survive in most waterways, providing there is very little pollution and as long as there is rainforest nearby, preferably gallery forest lining the riverbank. Those species that are adapted to arid areas are naturally tougher and more used to seasonal changes in their surroundings and are more resilient to habitat



► One of the last rainforest parcels in the Tolongoina area, SE-Madagascar. Here it was discovered one of the most threatened species of frogs, *Mantella bernhardi*.



change and degradation. However, species which have always had small ranges or are totally dependent on pristine forest are most at risk if deforestation continues. Since only a fraction of Madagascar's tropical forest remains, the frogs found only here face almost certain extinction if the current rate of destruction is sustained.

Frogs are extremely sensitive to their surrounding environment; not just the habitat but also chemicals and light levels. Frogs and toads are especially vulner-

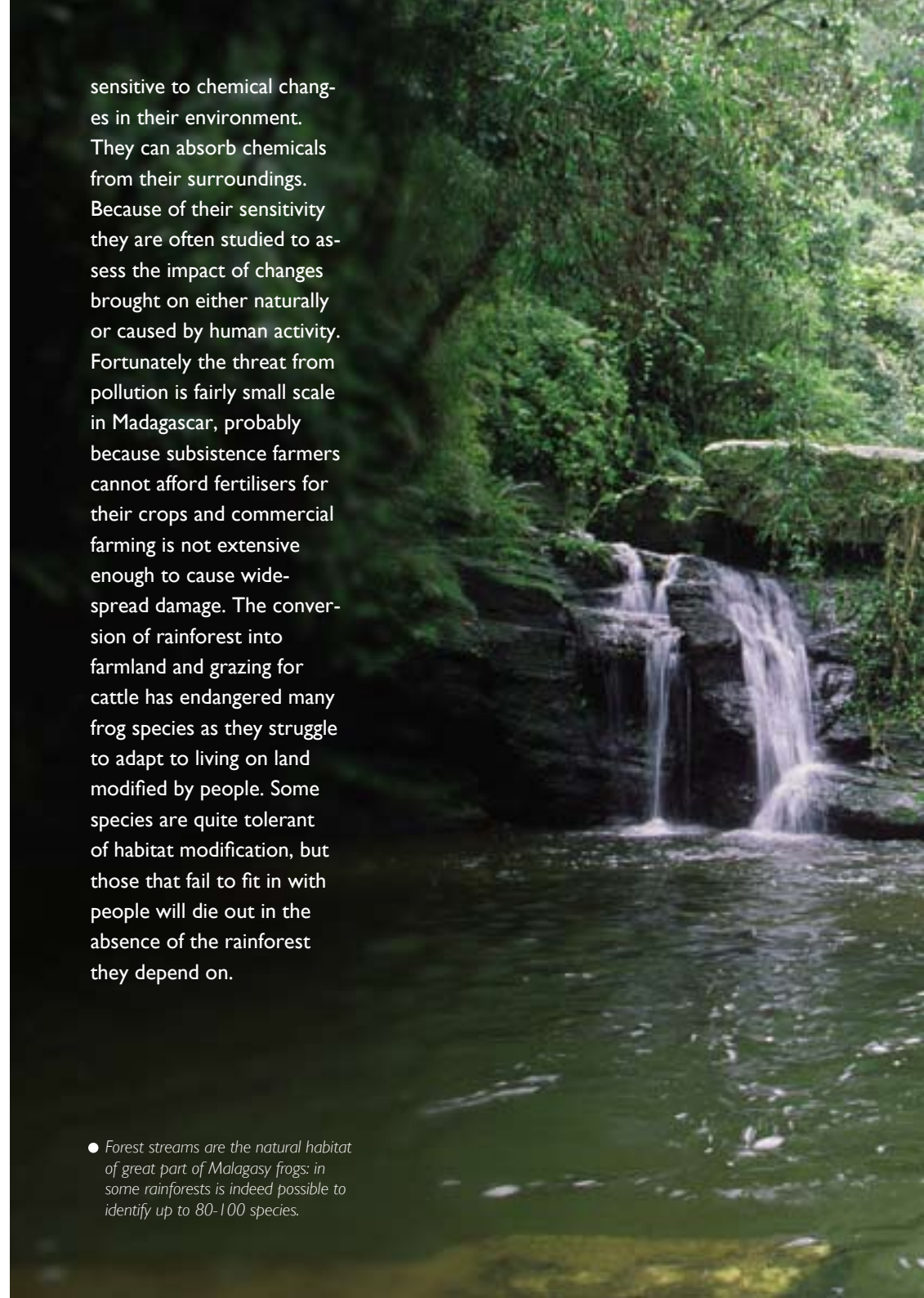
able to increased exposure to ultraviolet light, which can lower their immunity to diseases. Such exposure is caused by the thinning of the ozone layer, allowing more harmful light to reach the land surface. Pollution from human activity is the main cause for recent rapid climate change and the degradation of the ozone layer.

All frogs and toads have highly permeable skin; this means the skin easily draws in moisture and needs to stay moist if it is not to dry out. As frog's skins readily absorb moisture they are

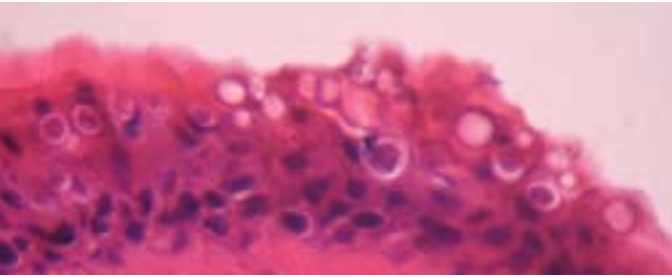
sensitive to chemical changes in their environment. They can absorb chemicals from their surroundings. Because of their sensitivity they are often studied to assess the impact of changes brought on either naturally or caused by human activity. Fortunately the threat from pollution is fairly small scale in Madagascar, probably because subsistence farmers cannot afford fertilisers for their crops and commercial farming is not extensive enough to cause widespread damage. The conversion of rainforest into farmland and grazing for cattle has endangered many frog species as they struggle to adapt to living on land modified by people. Some species are quite tolerant of habitat modification, but those that fail to fit in with people will die out in the absence of the rainforest they depend on.

● Forest streams are the natural habitat of great part of Malagasy frogs: in some rainforests is indeed possible to identify up to 80-100 species.

▼ The green mantella, *Mantella viridis*, is one of the critically endangered species of Malagasy frogs.



A frog-killing fungus



▲ A section of the skin of a frog affected by the chytrid fungus. The surface appears highly keratinised.

Amphibians are experiencing a dramatic decline worldwide. Apart from habitat alteration, one of the major threats to frog populations is the spread of *Batrachochytrium dendrobatidis*, a fungus that attacks only amphibians, commonly called “Bd” and can result in a disease called chytridiomycosis. The origin of this fungus is not well known, but it has been found in many parts of the world, in both altered and pristine environments. The fungus works by preventing gas exchange through the frog’s permeable skin, effectively suffocating the frog. Where the fungus has been found, frog populations have been greatly affected. Many species have already been attacked, and have either

become extinct or experienced dramatic declines in population sizes. At the moment there is no known cure and the only solution is to remove amphibian populations from the wild, taking them into captivity until the habitat is restored and the zoospores (transmittable part of the fungus) are killed. Chytrid fungus has yet to be discovered in Madagascar, and many studies are being conducted to monitor the health of wild frog populations. Because Madagascar’s frogs have been isolated from infections such as chytridiomycosis, it is unlikely that they would have developed any form of resistance to the fungus. If there is no resistance then the accidental introduction of chytrid to Madagascar would have a devastating effect on such an important and unique group of animals. For this reason hygiene during field surveys is essential, and amphibians must not be transferred from one site to another.

Amphibians as bush-meat



Some species of Malagasy frogs are collected by local people for food, particularly large species of the genus *Mantidactylus*, such as *M. guttulatus* in central-eastern Madagascar, and *Boehmantis microtypanum* from the south-east. In Malagasy these frogs are known as “radaka” or “baka-

ka”. Other species that are hunted for food include *Boophis goudoti* from the plateau region, and *Hoplobatrachus tigerinus*, a frog species introduced from South East Asia. Over-hunting or collecting for food, particularly when coupled with habitat changes, can often threaten frog populations.

▲ Hundreds of *Boophis goudoti* being prepared for cooking (high plateau of Madagascar)

The pet trade



▲ The harlequin mantella, *Mantella cowani*. This is the most threatened frog of Madagascar, surviving at only a few spots on the high plateau. Until recently it was also collected for the pet trade, but luckily this has been stopped.

Between 1996 and 2002 over 140 million amphibians were traded worldwide. In 1998 alone over 31 000 golden mantellas (*Mantella aurantiaca*) were exported from Madagascar for the global pet trade. The illegal pet trade is the most lucrative trade after the illegal drug trade and is the major source of income for many people living in the third world. Because animals are so valuable in the trade too many are taken from the

wild. Species most commonly traded are green mantellas (*Mantella viridis*), harlequin mantella (*Mantella cowani*), the Baron's mantella (*Mantella baroni*) and the expected mantella (*Mantella expectata*). Golden mantellas (*Mantella aurantiaca*) and tomato frogs (*Dyscophus* spp.) are particularly prized by collectors. Because they are active in the daytime and are brightly coloured, they are not only easy to catch but are also popular pets. Due to such high demand for these species they are being collected in huge quantities and taking consistently large numbers of animals from the wild in this way will eventually lead to their extinction. There are 9 critically endangered frog species, 21 endangered and 25 which are vulnerable in Madagascar if trade and habitat loss continues. Some species are protected by complete trade bans or restricted trade laws to control export but this can be difficult to regulate.

Research



▲ A still undescribed species of the genus *Boophis*. Recent estimates indicate that a huge number of Malagasy frogs still waits to be formally named.

Information on Malagasy frogs is limited as studying such a diverse group of animals is a complex and time consuming. Sometimes finding them in the first place is a major achievement; some species for example have an extremely small range. In some cases an entire species is only found near one stream or on one mountainside.

We still don't know enough about how many different species there are, the size of their populations, how

they breed or the kind of habitat they need. This knowledge is essential for protecting and conserving endangered frogs, so continued research is a necessity. Although many frog species are protected by law it is almost impossible to police collection of frogs. Most animals are smuggled out of the country so there is no accurate census of exportation. We just don't know how many frogs have been taken so far or how many are left.

Conservation

There is no doubt that Malagasy frogs face a myriad of threats; the illegal pet trade, habitat loss and environmental pollution. We know what the threats are but the real question is to how to stop these threats from wiping out entire species. By far the biggest threat to amphibians and many other animal groups is the loss of primary habitat, particularly on the eastern side of the island (rainforest). One of the most effective ways of preserving species in such areas is to create reserves or protected areas and to save the small forest fragments. In the past large tracts of rainforest in Madagascar have disappeared, mainly to make way for rice fields, to get charcoal and provide grazing land for cattle.

Approximately 10% of the original cover now remains and around 2,000 km² of forest is lost annually.

However, new initiatives such as the 'debt for nature' swap negotiated by the World Wide Fund for Nature (WWF) and the establishment of several new national parks (run by the National Association for Management of Protected Areas, ANGAP) have helped to slow the decline in Madagascar's biodiversity.

Other non-governmental organisations (NGO's) are also working in Madagascar such as the Madagascar Fauna Group, Durrell Wildlife Conservation Trust, Conservation International and WCS to name a few.





behaviour and general biology, making conservation very difficult. Hence many of the NGO's working on the island are collecting data on the basic biology of frog species. We do know that more than 80% of known species of threatened frogs in Madagascar are covered by the current system of reserves/protected areas, which helps to protect populations. For some species, particularly the colourful mantellas, the illegal pet trade forms a very real threat. The Convention of International Trade in Endangered Species (CITES) goes some way to helping maintain populations by regulating the number of frogs that are exported each year, or in some cases stopping all trade in them altogether.

For instance, recent recommendations have been made to suspend the commercial collection of *Mantella cowani* and add two species of *Scaphiophryne* to CITES Appendix II. The CITES Appendices are lists of plants and animals that have restricted levels of trade or

total trade bans. For example species in Appendix I are protected by complete trade bans, and species in Appendix II have restricted levels of trade. However, international trade may help preserve some species and their rainforest habitat by encouraging local communities to maintain the rainforest and therefore have a sustainable source of income by collecting a regulated number of frogs.

Involvement of local communities is perhaps the most important step in any successful conservation project. Throughout the world it is important to understand how we fit into our environment and the implications of our actions. For instance, destruction of

rainforests will lead to many amphibian, reptile, bird, mammal and plant species becoming extinct, as well as contributing to soil erosion.

To quote Madagascar's President Marc Ravalomanana "This is not just Madagascar's biodiversity, it is the world's biodiversity". Madagascar's amazing and unique biodiversity, including its incredible frogs, is for everyone to both help protect and admire. Working with and alongside the Malagasy people, we hope in a small way to contribute in conserving this incredible island.

▲ Studying frogs in the forest always needs capacity of adaptation and long walks

The Madagascar Fauna Group is an association of zoos from around the world that assist the Malagasy government with biodiversity conservation by supplying funds, expertise and helping to run field research projects. Successful reserves and protected areas cannot be created unless there is firm understanding of the biology of the target species to be conserved. For many of Madagascar's frog species very little is known about their distribution, population density, breeding



◀ A beautiful *Mantella nigricans*, a typical inhabitant of the rainforests of northern Madagascar

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The Amphibian Specialist Group / Madagascar Chair
c/o Wildlife Conservation Society, Antananarivo, Madagascar
www.sahonagasy.org

The International Society for the Study and Conservation of Amphibians
Vertébrés: Reptiles & Amphibiens, Muséum national d'Histoire naturelle, 25, rue Cuvier, 75005 Paris, France
www2.mnhn.fr/alytes/

The site of **AmphibiaWeb**, addressed to the conservation of the amphibians, with detailed sheets and photographs of all the amphibian species
www.amphibiaweb.org

The Global Amphibian Assessment
The GAA webpage, for the threatened amphibians of the world
www.globalamphibians.org

Conservation International Madagascar
6 Rue Razafindratandra, Ambohidahy, BP 5178, Antananarivo 101, Madagascar
www.conservation.org



The **Amphibian Specialist Group (ASG)** is a network of conservation professionals working within the IUCN/SSC framework to promote amphibian research and conservation worldwide. The ASG strives to raise amphibian conservation to the next level by stimulating, developing, and executing practical programs to conserve amphibians and their habitats around the world. The ASG has recently published the "Amphibian Conservation Action Plan" (ACAP), a comprehensive five-year plan designed to halt the current extinction crisis. The ACAP can be downloaded for free from www.amphibians.org. This plan represents a template for amphibian conservation at all scales from global to local scale.

ACSAM



A Conservation Strategy for the Amphibians of Madagascar

A Conservation Strategy for the Amphibians of Madagascar (ACSAM) is a project designed to achieve the conservation of the amphibians of Madagascar. ACSAM is a monumental effort by committed individuals that represents an important step forward in implementing the ACAP at the national level. The ACSAM has the potential to serve as a model for developing National Action Plans for amphibian conservation in many other parts of the world. News about the ACSAM can be downloaded at www.sahonagasy.org.



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