



MEF

Species Conservation Strategy for  
*Mantella aurantiaca* (The Golden Mantella Frog)

2011-2015



**Partners :**



## **Species Conservation Strategy for *Mantella aurantiaca* (The Golden Mantella Frog), 2011-2015.**

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Roma Randrianelona and J. Christian Randrianantoandro  
Madagasikara Voakajy, B.P. 5181, Antananarivo (101), Madagascar

Nirhy Rabibisoa  
Amphibian Specialist Group, c/o Conservation International, Explorer Business Park,  
Batiment C2, Ankorondrano, B.P. 5178, Antananarivo 101, Madagascar

Harison Randrianasolo  
Conservation International, Explorer Business Park, Batiment C2, Ankorondrano, B.P. 5178,  
Antananarivo 101, Madagascar

Sahondra Rabesihanaka  
Service de la Gestion de la Faune et de la Flore, Direction de la Valorisation des Ressources  
Naturelles, Ministère de l'Environnement et des Forêts, B. P. 243, Antananarivo, Madagascar

Sahoby Randriamahaleo  
Direction de la Conservation de la Biodiversité et du Système des Aires Protégées, Ministère  
de l'Environnement et des Forêts, B. P. 243, Antananarivo, Madagascar

Richard K. B. Jenkins  
Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation,  
University of Kent, Canterbury, United Kingdom and, Madagasikara Voakajy, B.P. 5181,  
Antananarivo (101), Madagascar

**Photograph on the cover page:** a female *Mantella aurantiaca* in the forest of Ambinanilemafy, Mangabe, Commune Ambohibary, Moramanga District, (by Roma Randrianelona in 2009).

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## FOREWORD

La richesse biologique de notre pays est caractérisée par son taux d'endémicité élevé et parfois localisé à l'échelle régionale. *Mantella aurantiaca* ou Sahona menakely est une espèce qui se trouve uniquement dans le District de Moramanga. C'est la raison pour laquelle elle devient à la fois l'emblème du District et celui de la zone humide de Totorofotsy. Actuellement, elle est aussi l'espèce clé dans la promotion de la Nouvelle Aire Protégée de Mangabe-Ranomena.

Malheureusement, à cause de la perte et de la fragmentation d'habitat qui continue à un rythme alarmant souvent d'origine anthropique, l'espèce est actuellement classée comme Gravement Menacée dans la Liste Rouge de l'Union Internationale pour la Conservation de la Nature (IUCN).

Les conséquences de la surexploitation et du changement climatique qui pèsent sur nos ressources naturelles en général et sur cette espèce en particulier, restent encore à déterminer. Ces menaces affectent les moyens de vie des riverains qui dépendent directement de ces ressources naturelles. D'où le défi pour Madagascar de prendre des mesures pour réduire la pauvreté tout en parvenant à préserver notre biodiversité unique.

Étant convaincu, avec les autres nations, que les ressources naturelles qu'abritent nos zones humides et nos forêts sont renouvelables mais pas intarissables, Madagascar a ratifié des conventions ayant des liens directs sur la conservation à l'instar de la Convention sur la Diversité Biologique, de la Convention RAMSAR sur les Zones Humides d'importance Internationale et de la Convention Internationale sur le Commerce des Espèces en danger (CITES).

Par ailleurs, lors de la dixième conférence de la convention sur la diversité biologique à Nagoya, un des défis défini était que l'extinction des espèces actuellement menacées, y compris la *Mantella aurantiaca*, serait évitée en 2020, et que leurs statuts seraient améliorés et puis maintenus durablement. D'où la nécessité de l'élaboration de la présente stratégie qui est un outil capital pour l'atteinte de cet objectif.

Aussi, le Ministère de l'Environnement et des Forêts félicite-t-il, l'équipe de l'Association Madagasikara Voakajy et tous ses partenaires à Madagascar et à l'étranger d'avoir pu produire ce document qui constitue un outil de travail et d'orientation dans l'exécution des activités de conservation et de la gestion de Sahona menakely ou *Mantella aurantiaca*.

Toutes les parties prenantes sont appelées à contribuer dans la mise en oeuvre des activités définies par cette stratégie afin qu'elle soit un modèle pour les autres espèces menacées et que le succès de sa réalisation devienne des références pour les initiatives visant à concilier la conservation et le développement humain à Madagascar.





## Acknowledgment

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The Direction de l'Environnement et des Forêts (DGEF) and its team would like to sincerely thank the various parties involved that gave contributed to the development of this conservation strategy for *Mantella aurantiaca*, which is a regionally endemic species also seriously threatened according to the IUCN classification.

We thank Madagasikara Voakajy and its team for their initiative and devotion during the development process of this conservation strategy.

We would also like to express our gratitude to the regional and district authorities involved, particularly the Chef District of Moramanga, the mayors of the communes of Ambohibary and Beparasy, the regional representative of the Direction Régionale de l'Environnement et des Forêts Alaotra Mangoro, the Chef de la Circonscription de l'Environnement et des Forêts in Moramanga, the Chef Cantonnement, the Antsily, Ampahatra, Manakana-Est and Ambodirotra Fokontany village leaders, the Lakambato village chief, the local leaders (tangalamena) of Moramanga, Mangabe and Manakana-Est for their active participation in the development and implementation of this strategy.

We express our gratitude also to the members of the CITES Fauna Scientific Authority (Department of Animal Biology, University of Antananarivo), to the associations of local exporters and collectors for their contribution during the development process and especially the implementation of this strategy.

We thank the various conservation institutions and communities that have actively participated in this conservation strategy, namely the Amphibian Specialist Group (IUCN/SSC), the Executive Secretary of the ACSAM (A Conservation Strategy for Amphibians of Madagascar), Conservation International, the Environment Section of the Ambatovy project, Madagascar National Parks, ONG Mitsinjo, ONG Man And The Environment, Plateforme pour la gestion du Corridor Ankeniheny-Zahamena (PLACAZ), Office National pour l'Environnement Moramanga, Office Régional du Tourisme Alaotra Mangoro (ORTALMA), Conseil aux Services Agricoles TSIRIMANGA Moramanga, Fédération des Communautés de base Miaradia, VOI (Vondron'Olona Ifotony) TARATRA Torotorofotsy, VOI Hafasahona Mangabe, VOI Faniry Ambodirtotra, VOI Miara-mirindra Manakana-Est, VOI Fanazava Andranomandry, VOI Soamifara Ampahatra, VOI Fitahiana PK 33, VOI Mahaso Mahatsara Ampasimaneva.

And finally, we would also like to express our gratitude to all artificial and natural persons, not cited, who contributed closely or from afar to the carrying out of this strategy. We also hope for your contribution so that it can be effective in the five coming years.

### **Funded by:**



## ACRONYMS

- ACSAM : A Conservation Strategy for the Amphians of Madagascar
- ACAP: Amphibian Conservation Action Plan
- Bd : *Batrachochytrium dendrobatidis*
- CIREF: Circonscription de l'Environnement et des Forêts
- CITES: Convention on International Trade in Endangered Species
- CDB: Convention sur la Diversité Biologique
- COAP: Codes des Aires Protégées
- CR : Gravement Menacée (selon la liste rouge de l'IUCN)
- FKT: Fokontany
- IEC: Information Education et Communication
- MEF : Ministère de l'Environnement et des Forêts
- MEM: Ministère de l'Energie et des Mines
- NAP: Nouvelle Aire Protégée
- SAP : Sahonagasy Action Plan
- SAPM : Système des Aires Protégées de Madagascar
- SMART : Specific, Measurable, Attainable, Relevant and Time-bound
- UICN : Union Internationale pour la Conservation de la Nature
- VOI: Vondron'Oloha Ifotony (Community-based association to which the management of natural resources is transferred)

## I-INTRODUCTION

The Madagascar amphibian fauna is unique in the world because of its high (almost 100%) level of endemism (Vieta et al. 2009). This future of Madagascar's frogs is threatened by habitat loss and climate change, as well as the possible arrival of the chytrid fungus. A national conservation plan for amphibians (ACSAM) was created in 2006 to help Madagascar to address these threats and was closely linked to the global action plan for amphibians produced by the IUCN/SSC Amphibian Specialist Group in 2005.

The Sahonagasy Action Plan (SAP) is the implementation component resulting from the ACSAM workshop in 2006 (Andreone et Randriamahazo 2008). This plan is a five year initiative aimed at promoting the conservation of Madagascar's amphibians. Eight strategies were identified and they focused on the coordination, research and monitoring, diseases, captive breeding, protected areas, commerce, climate change and the development of the unique national herpetological collection (Andreone et Randriamahazo 2008). Given the lack of resources to implement the whole SAP, and the great number of threatened amphibian species, it was necessary to identify priority actions.

Thus, Madagasikara Voakajy initiated a conservation and sustainable management programme for *Mantella aurantiaca* and its habitats, which started with a scientific study in 2007 (Randrianelona et al. 2010). In 2008, Conservation International funded Madagasikara Voakajy, with a Conservation Action Grant, to promote the integration of the Mangabe-Sahasaroetra-Ranomena forest block into the System of Protected Areas of Madagascar (SAPM) to protect *Mantella aurantiaca* and its habitats. The forests block then obtained preliminary protected status according to the Interministerial decree n°52005/2010.

In general, the methodology adopted in this strategy follows the various steps described in the guide developed by the IUCN in 2008 (Strategic Planning for Species Conservation: A Handbook - The Species Conservation Planning Task Force Species Survival Commission, IUCN Version 1.0). According to this guide, a participative development based both on scientific principles and the participation of a wide range of parties is necessary to save a species. Thus, a species conservation strategy must include the complete review of the species' status, the vision and objectives for saving the species,

the purposes to be reached in order to reach these goals and the actions to undertake in order to accomplish these objectives. Not only must the coherence between these various components be in order to ensure the effectiveness and efficiency of the strategy, but adhere to the SMART principle (Specific, Measurable, Attainable, Relevant and Time-bound) must be obvious.

Following a workshop with the participation of all relevant stakeholders and a few work post-workshops sessions, the final product consists of: a complete review of *M. aurantiaca* status, a vision, five main goals, twelve specific goals, seven objectives, sixteen specific objectives and fifty actions to be undertaken over the next five years.

## A- *M. aurantiaca* STATUS REVIEW

### 1 Species description

#### 1-1 Name of the species

**Scientific name:** *Mantella aurantiaca* Mocquard, 1900

**Vernacular name:** Golden Mantella (English), Sahona Mena (Malagasy),

#### 1-2 Photographs of the species



A



B



C

*Mantella aurantiaca* (A, B: Roma Randrianavelona ; C : Evan-Bowen Jones):

#### 1-3 Status of the species

##### IUCN Red List:

*M. aurantiaca*'s conservation status is Critically Endangered, B2ab (iii, v) (Vences et Raxworthy 2004). Its area of occupation is less than 10 km<sup>2</sup> and its habitats are declining. Its population is also quite fragmented (Vences et Raxworthy 2004).

##### CITES:

*M. aurantiaca* is on Annex II of CITES and a quota which is not harmful to the wild population is published every year.

##### EDGE:

*Mantella aurantiaca* holds the 140<sup>th</sup> rank out of the 4,339 threatened amphibians ([www.edgeofexistence.org](http://www.edgeofexistence.org)).

##### National legislation

*M. aurantiaca* is a protected species according to the Decree n° 2006-400 related to the classification of wild fauna species, June 13, 2006) (Class I, Category II). Collecting in the wild is permitted provided that a permit is given by the Ministry of the Environment and Forest

## 1-4 Description

### **Genetics**

The result of molecular studies confirms that *M. aurantiaca* is distinct from *M. milotympanum* and *M. crocea* (Chiari et al. 2004). The red form, *M. aurantiaca rubra* - from Anosibe An'ala in the south [of its range] was proposed as a sub-species but this was later rejected by Vences et al. (1999) because of a lack of evidence.

### **Morphology**

A small but stout and vividly colored frog varied between bright orange and red coloration (Vences et al. 1999). Snout vent length is usually 19-24 mm, but occasionally large females reach 31 mm (Glaw and Vences 2007). Morphological studies of *M. aurantiaca* from a single site revealed that males were significantly smaller than females (Woodhead et al. 2007).

### **Reproduction**

Eggs are deposited in rubbish and leaf-litter outside of water with a clutch-size of 20-60 eggs which reach maturation in two weeks (Anon 2008).

## 2- Functions and values

### **Ecosystem function**

*M. aurantiaca* is a predator of litter fauna and Acari, Amphipoda, Collembola, Formicidae (non-winged), Diptera, Thysanoptera and Isopoda (Woodhead et al. 2007).

### **3- Utilization**

*M. aurantiaca* has been collected from the wild for commercial purpose as well as for scientific research. It is quite popular in the exotic pet trade. Uses of this species also include commercial display in zoos, aquaria as well as in private collections. *Mantella aurantiaca* is held in a number of private and public institutions, mainly in North America and Europe. A population of 694 frogs in captivity was reported for 2009 from 51 different institutions ([www.isis.org](http://www.isis.org)). Little information on the domestic use of *M. aurantiaca* is available but living individuals are held in a farm (Croc farm) in Antananarivo, at the Parc Botanique et Zoologique de Tsimbazaza (Antananarivo) and the Parc Exotique de Madagascar (Mandraka). *M. aurantiaca* accounted for 50%



of the Mantella frogs exported from Madagascar between 1994 and 2003 (Rabemananjara et al. 2008a). North America (United States and Canada) and Western Europe were the largest importers of Mantella frogs from Madagascar (Rabemananjara et al. 2008). Since 1995, the trade in wild *M. aurantiaca* from Madagascar has been monitored by CITES. No exportation of *M. aurantiaca* was been reported between 2003 and 2008 although a quota of 2,500 frogs was agreed by CITES in 2009 and 550 frogs in 2010.

This species is used to promote tourism and conservation in Madagascar (<http://parcs-madagascar.com>). It is also the emblem of the Torotorofotsy RAMSAR site and of the Moramanga District. It is also the key species to promote the new protected area of Mangabe.

#### **4- Historical background**

Historically, the area of distribution of *M. aurantiaca* was larger than present (Figure 1). The holotype was collected from between Moramanga and Beforona (Vences et al. 1999). Some old specimens were attributed to the sites in Andasibe (Perinét), but Vences et al. (1999) consider these to be erroneous or introduced individuals. A number of localities have been reported from the Torotorofotsy wetland which is located at less than 15 km from Andasibe (Zimmermann and Hetz, 1992; Zimmermann 1996).

Vences et al. (1999) verified a number of specimens and concluded that *M. aurantiaca* was found in three different localities – Beparasy (Mangarivotra) Anosibe An’ala and the Torotorofotsy swamp. The unpublished report of Behra et al. (1995) refers to a number of other localities that do not appear in subsequent assessments (Vences et al. 1999; Glaw and Vences, 2007). The validity of the observations by Behra et al. (1995) was questioned by Vences et al. (1999) because of potential confusion with *M. milotympanum* which was not formally accepted as a different species by herpetologists until 1996.

This explanation may also be relevant to the unpublished thesis of Ramilison (1997) that reports the presence of *M. aurantiaca* at Fierenana. However, the known distribution of *M. milotympanum* is restricted to the forest area east of Fierenana (Bora et al. 2008) and could only account for two localities in Behra et al. (1995) and three in Ramilison (1997). Other sites

listed by Behra et al. (1995) and three in Ramilison (1997). Other sites listed by Behra et al. (1995), but ignored by later authors include Maromizaha and Ambavaniasy which are east of the accepted area of distribution of *M. aurantiaca* at a slightly lower elevation. The presence of the species in the Vohidrazana forest further indicates that *M. aurantiaca* has been observed outside of its current range (J. C. Randrianantoandro, pers. Obs.). Vieites et al. (2009) surveyed Maromizaha, Vohidrazana, Ambavariasy and five other localities in the vicinity but *M. aurantiaca* was only found in Torotorofotsy.

The most unusual observation by Behra et al. (1995) was the sighting of *M. aurantiaca* near the Ankaratra massif, Ambatolampy. *Mantella cowani* is known from high elevation sites in the central high plateau of Madagascar but is a very different frog in appearance to *M. aurantiaca* and no confusion could exist in distinguishing the two taxa. Based on the habitat and elevational range associated with the presence of *M. aurantiaca*, it would be surprising to discover the species west of Ambatolampy at elevations above 1,300 m in areas without humid forest. However, Vences et al. (1999) reported the presence of *M. cowani* in the forests south-east of Ambatolampy and Andreone et al. (2007) also reported a *M. cowani* population at Antratrabe near the humid forest corridor south-east of Ambatolampy. The recent discoveries of *M. aurantiaca* and *Mantella* cf. *crocea* west of the Mangoro River indicate that there may be other existing or extinct population of these species in areas still poorly known by herpetologists (Bora et al. 2008).

## **5- Distribution and demography**

### **5-1 Recent surveys**

Surveys between 2000 and 2010 have revealed three distinct areas with *M. aurantiaca* (Figure 2). The forests south of Moramanga in the Communes of Ambohibary and Beparasy form a notable cluster with a number of localities confirmed (Bora et al. 1998; Randrianelona et al, 2010). The second main cluster is located north-east of Moramanga town around the Torotorofotsy wetland (Bora et al. 2008; Randrianelona et al. 2010). The most curious outliers occur to the north-west of Moramanga in the Ambakoana area, two sites where *M. aurantiaca* was discovered in 2007 (Bora et al. 2008). In sum, three sites occur west of the Mangoro River, all of which are rather isolated and are found in small forest fragments (Bora et al. 2008). With the exception of these three outliers where *M. aurantiaca* has only been observed once, other sites in most cases represent repeated observations.

## 5-2 Current distribution

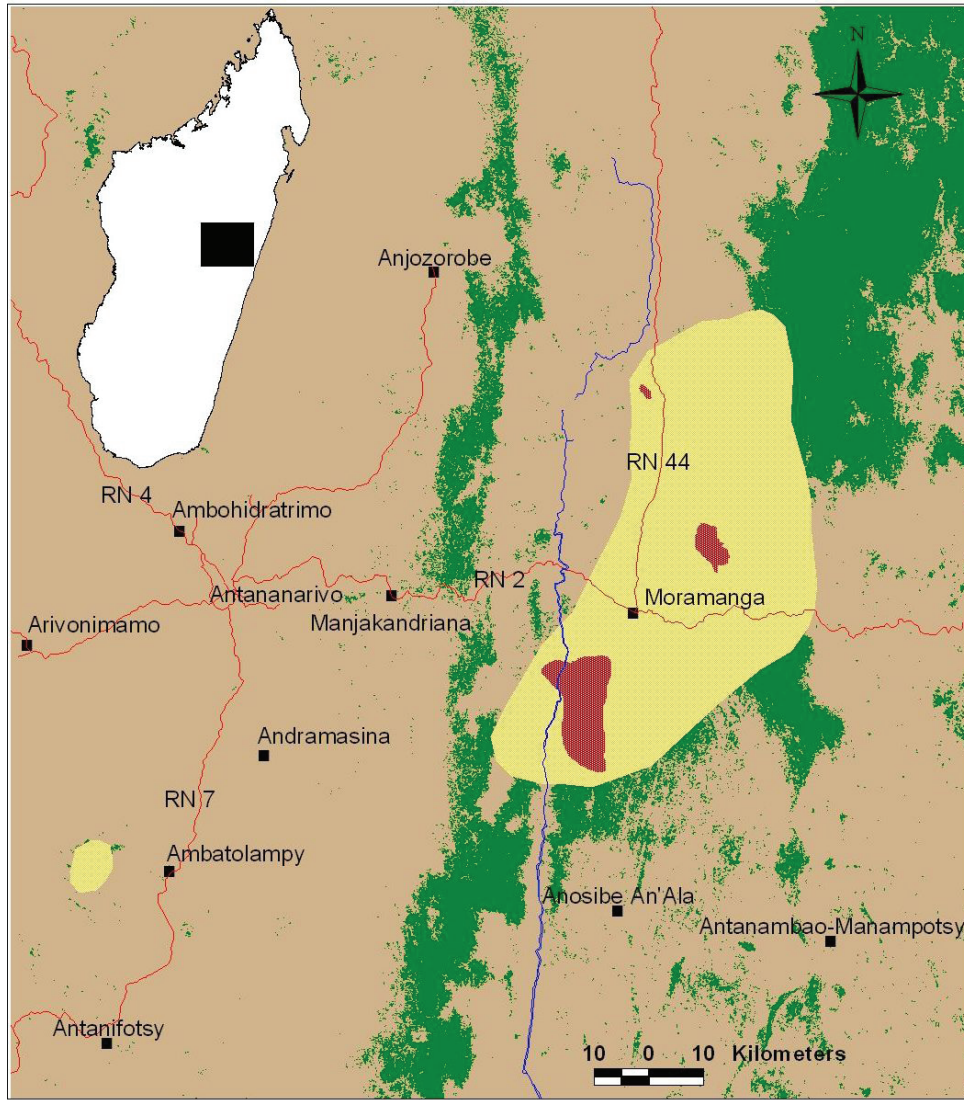
The current distribution is obtained from the results of recent surveys (2000-2010) and shows a distribution with Moramanga at the centre. According to the polygons shown in Figure 3, the extent of occurrence is 1,189 km<sup>2</sup> and the area of occupancy is 112 km<sup>2</sup>. These estimates are significantly reduced to 626 km<sup>2</sup> and 89 km<sup>2</sup> if the outlying populations are not included. The majority of *M. aurantiaca* sites identified are either associated with the Mangoro River tributaries or the Torotorofotsy wetland and its tributaries. The former can be divided into two distinct populations, Mangabe and Analabe, which form convenient focii for conservation attention. However, the sites around the Torotorofotsy wetland are distributed in forest that are managed by different entities, are subject to several kinds of threats and occur in different watersheds.

## 5-3 Identifying populations:

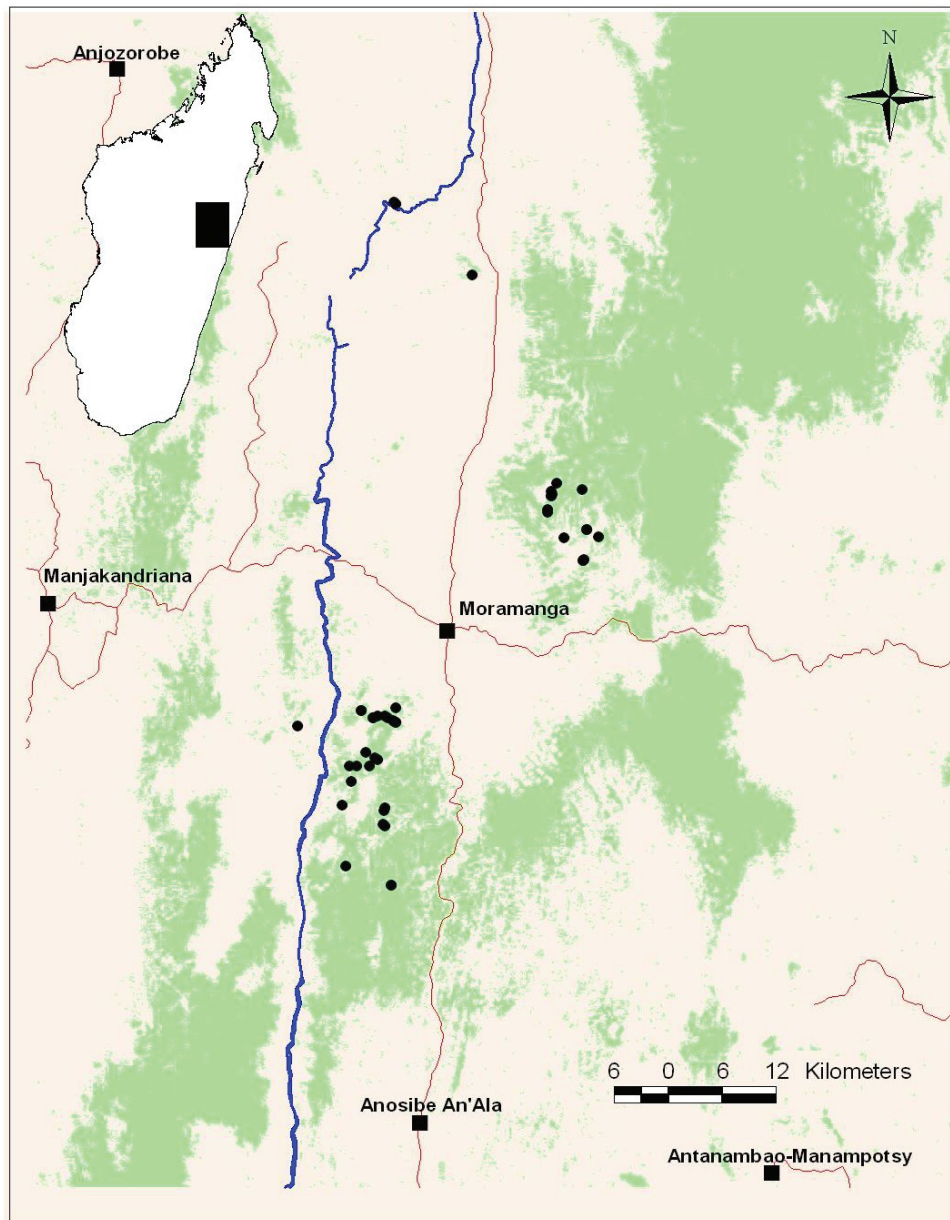
For conservation of the species we propose that the *M. aurantiaca* sites be treated as four different populations based on data collected during 2000-2010. This classification is not based on biological principles of populations but rather reflects geographic position and management scenarios that exist, or are predicted, at each site.

### 1 Mangabe (21 localities)

The Mangabe forest is the only forest massif that stretches across the boundary between the districts of Moramanga and Anosibe An'ala. The northern part of this forest, in the Mangarivotra and Ambohibary communes, is a provisional protected area whilst the southern part of the forests has been allocated for sustainable forest management. A single site occurs west of the Mangoro River (Fatakana, Vodiriana commune).

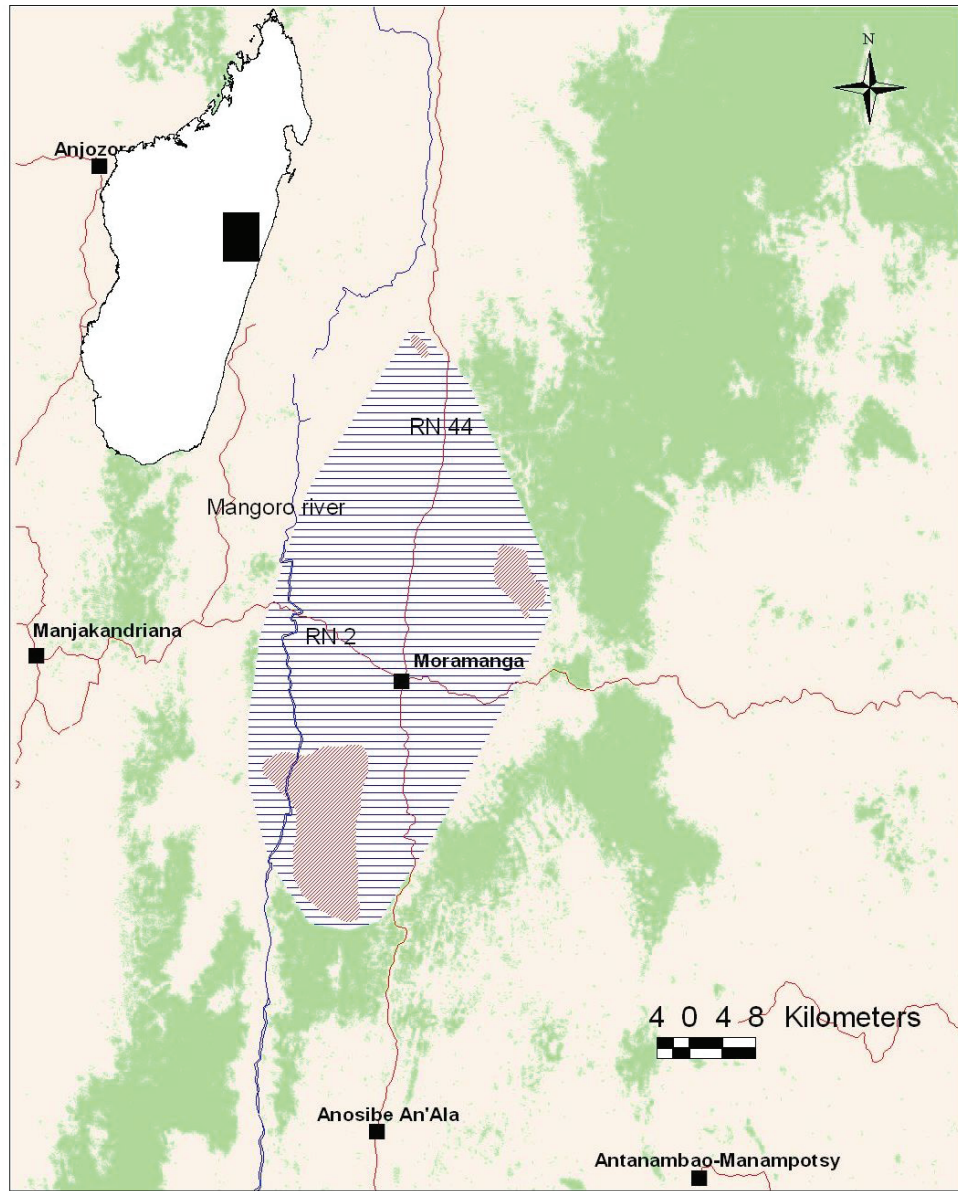


**Figure. 1.** Past (yellow) and present (red) distribution of *Mantella aurantiaca*.



**Figure 2:** A map showing the localities of *M. aurantiaca* (2000-2009). The humid forest is colored in green and the black squares are the commune towns.





**Figure 3:** A map showing the occurrence extension area (hatching) and occupation area (pink) of *M. aurantiaca*. The green one is the humid forest and the black squares are the commune towns.



2 **Ambatovy**: Mine footprint (8 known localities); buffer zone (5 known localities); conservation zone (3 known localities).

These sites occur in the Ambohibary commune. They are expected to undergo severe habitat disruption in the next seven to fifteen years when the forest that shelters them is removed by the mine. The exact limit of the mine footprint could shift within the buffer zone proposed in response to mining priorities. The Ambatovy Project has produced a *Mantella* Management Programme to guide the conservation of these sites during the life of the mine

3 **Torotorofotsy**: Zahamena-Ankeniheny corridor (New Protected Area with 1 known site), Ambatovy Pipeline (Ramsar zone with 1 known site, Torotorofotsy inside Ramsar (3 known sites).

These sites are located in the commune of Andasibe and are managed by different organizations. But all of them are located within the Torotorofotsy wetland.

4 **Analabe** (2 known localities)

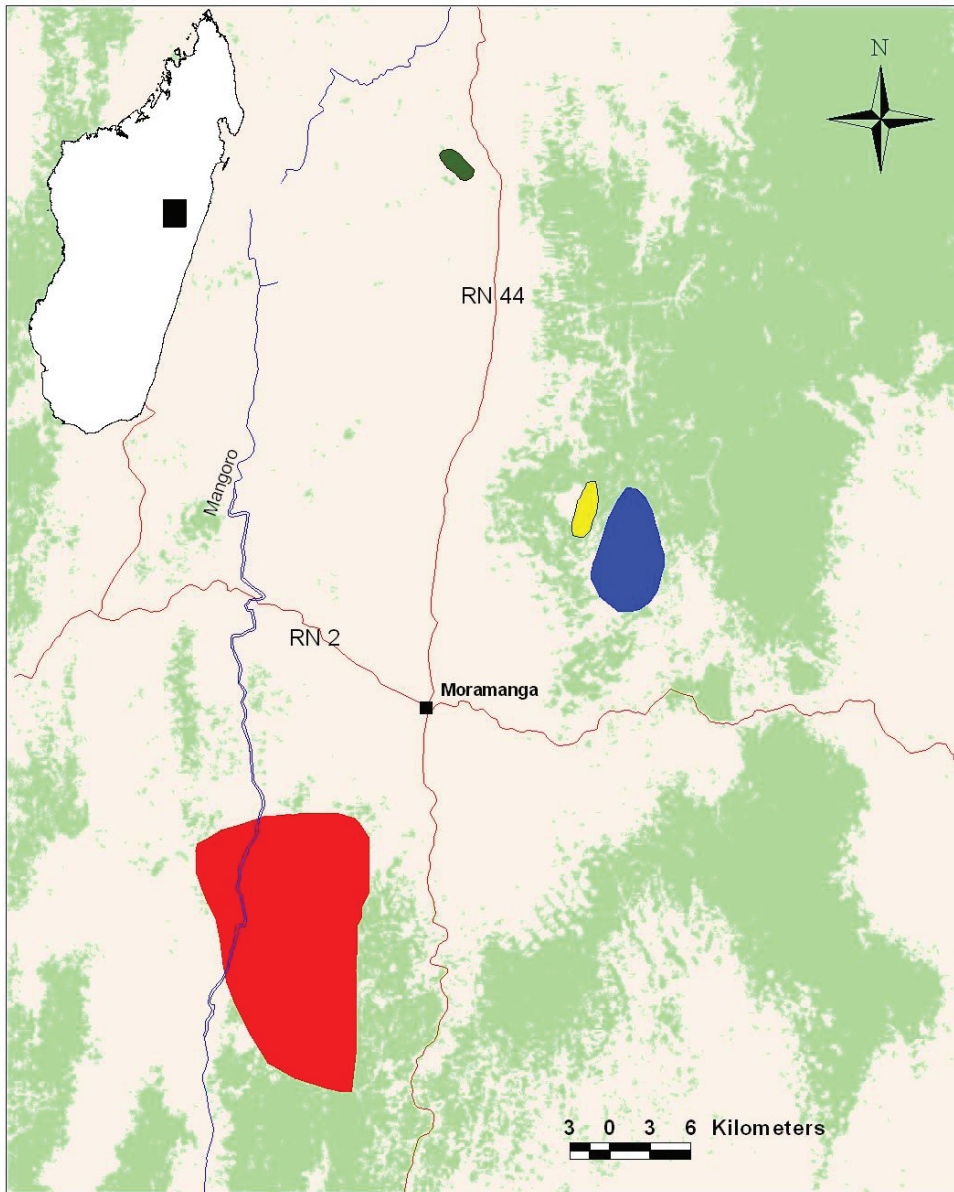
These sites are located in the commune of Andasibe and are managed by different organizations. But all of them are located within the Torotorofotsy wetland.

#### 5-4 Demographic analysis

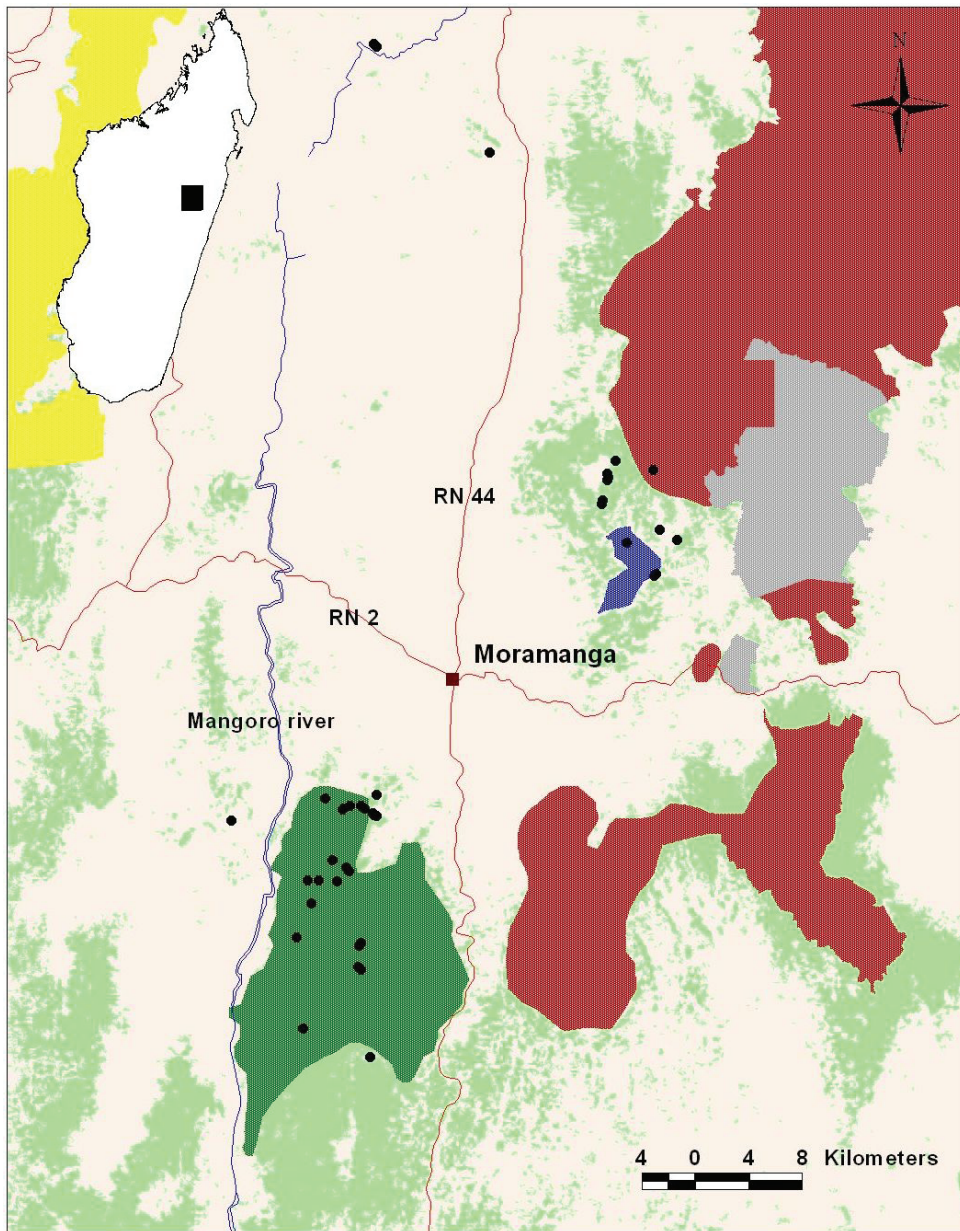
There are few estimates available of the abundance and density of *M. aurantiaca*. Nevertheless, because of the perceived importance of proving density estimates to inform discussions on export quota, a number of different survey teams have produced estimates. Obtained values range between 500 and 3,000 individuals per hectare (Behra et al. 1995) and between 836 and 1,371 ha<sup>-1</sup> (Rabemananjara et al. 2008b). There is no published quantitative data on temporal and seasonal variation of the abundance of *M. aurantiaca*. Furthermore, extrapolating density estimates to a population from data collected when frogs are aggregated during the breeding season is of limited value (Rabemananjara et al. 2008b).

### **5- 5 Habitat types and follow-up**

There is a little quantitative information available concerning the habitat that *M. aurantiaca* requires, with observations from only in two localities during the austral summer. The species appears to require small lentic wetlands for reproduction. Adults aggregate around these wetlands during the breeding season (Randrianelona et al. 2010). The extent to which these ponds are temporary or free of predators is unknown. *M. aurantiaca* is associated with humid forest between 873 and 1,054m above sea-level (Randrianelona et al. 2010). The species is reported to live in swamp forests in association with *Pandanus* screw pines (Andreone et al. 2005; Anon 2008; Vences et al. 1999).



**Figure 4:** The four conservation units of *M. aurantiaca*: Mangabe (in red), Ambatovy (in yellow), Analabe (in green) and Torotofotsy (in blue).



**Figure 5:** A map showing the various land tenure and use: in grey: protected area IUCN Category II; in yellow and red: protected areas IUCN category VI having temporary status in 2005; green protected area IUCN category VI having global temporary status in 2008 and in blue: the RAMSAR site.

*M. aurantiaca* tolerates a certain degree of forest disturbance and occupies a range of sites that vary both in vegetation structure and fragment size (Andreone et al. 2005). Recent discoveries of *M. aurantiaca* reflect concerted effort to survey potential habitat within, or just outside its known range (Bora et al. 2008). Deforestation is evident from satellite images and aerial photographs around the Mangabe and Torotorofotsy populations (Harper et al. 2007). Humid forests closest to the main road and Moramanga town suffered the most notable declines during the period between 1997 and 2000.

A significant part of the humid forest around Moramanga is now included in protected areas (Figure 5). There are two protected areas managed by Madagascar National Parks (Parc National de Mantadia and Reserve spéciale d'Analamazaotra) but no *M. aurantiaca* site is known from these forests. The Zahamena-Ankeniheny corridor is a new protected area that is currently undergoing transfer from temporary to definitive status. A single *M. aurantiaca* locality is known from the area. The Mangabe forests were awarded provisional protected area status in October 2008. Both Zahamena-Ankeniheny Corridor and Mangabe will have sustainable use management areas within their boundaries and are thus different category (category IV) to Parc National de Mandatia and Reserve spéciale d'Analamazaotra (category II). Torotorofotsy is a RAMSAR site and some areas of this watershed form part of the Ambatovy mining project.

## **6 Threat analysis**

*Mantella aurantiaca* and its habitats are subject to a number of ongoing threats. These are likely to be compounded in the future by other threats that are anticipated to have a negative impact.

### **6-1 Agriculture and aquaculture:**

#### **Annual and perennial non-timber crops**

Humid forest is cleared using slash and burn to provide new agricultural land for crops such as rice, cassava and others.



## **6-2 Energy production and mining:**

### **Mining and quarrying**

*M. aurantiaca* habitats in Mangabe are threatened by illegal gold mining that started recently. These activities are degrading aquatic habitats through the removal of waterside trees and increasing turbidity. Some of *M. aurantiaca* habitats in Ambatovy will be removed during the operation of nickel mine whilst other sites are within the 100 m buffer zone of the mine's footprint and will also inevitably be impacted.

## **6-3 Biological resource use:**

### **Hunting and collecting**

Mangabe and Torotorofotsy are traditional collecting sites for *M. aurantiaca* for commercial purposes according to surveys in the villages. The impact of this collection on local populations is poorly known but has been suggested to be minimal (Andreone et al. 2005). Nevertheless, it is conceivable that over collection could negatively impact the survival of *M. aurantiaca* at certain sites.

### **Logging and wood harvesting:**

Forest in Mangabe is subject to ongoing working for commercial and subsistence purposes. Timber removal appears to be mostly selective but introduces notable changes to the forest structure by increasing light penetration. The felled logs are processed in the forest and the discarded wood shavings frequently accumulate in the aquatic habitats.

## **6-4 Natural systems modifications:**

### **Fires**

Fires drastically alter the vegetation structure of humid forest in the sites occupied by *M. aurantiaca*. Fires-induced losses of under story and dead-wood reduce the quality of the habitat for *M. aurantiaca*.

## **6-5 Invasive and other problematic species and genes:**

### **Invasive alien species**

The disease *Chytridiomycosis* caused by the fungus *Batrachochytrium dendrobatidis* (Bd) is a major threat to the world's amphibians. Weldon et al. (2008) screened 527 frogs of which 79 species were from Madagascar and all clear of *Batrachochytrium dendrobatidis*. This disease however remains



a serious potential threat to *M. aurantiaca* because it causes catastrophic declines in amphibian communities when introduced into new areas.

#### **6-6 Pollution:**

##### **Garbage and solid waste**

Felled logs during commercial timber extraction are processed in the forest and the discarded wood shavings frequently accumulate in the aquatic habitats important for *M. aurantiaca*. This also likely poses a threat to *M. aurantiaca* populations in Ambatovy unless measures are developed in advance.

#### **6-7 Climate change:**

##### **Habitat shifting and alteration**

Changes in the vertical distribution of species are one symptom of global warming. Species are forced to follow the shifting microclimate into areas that are unsuitable (Raxworthy et al. 2008). There is also concern that the fungus (*B. dendrobatidis*) becomes more virulent under certain temperatures and that climate change may increase the risk of this disease from impacting amphibian populations. Furthermore, as habitat fragmentation isolates species with limited dispersal abilities, their capacity to adapt to climate change may be diminished. Species most at risk are montane endemics but others, such as *M. aurantiaca*, with a limited elevational range and restricted distribution are also threatened.

## B- DECLARATION OF VISION

Our vision of *M. aurantiaca* is that its populations and habitats are valued, protected, restored and monitored and equitably managed in a legal and sustainable manner. Interventions should meet local needs but maintain ecosystem services and, over the long term, secure natural resources and landscapes through the effective participation of local, national and international parties.

## C- GOALS

The goals have been developed to make the vision operational. The specific goals, objectives, specific objectives and the actions corresponding to these goals are presented in the next section:

**Goal 1:** To protect and restore terrestrial and aquatic habitats essential for the species to maintain genetic diversity, viable population size and ecological functions in its current area of distribution.

**Goal 2:** To preserve the scientific, economic, social and cultural values of the sites through encouraging their protection.

**Goal 3:** The direct and indirect rational exploitation of *M. aurantiaca* and its habitat comply with the local rules and national legislation (New Protected Areas, Codes for Protected Areas, hunting law...) as well as international treaties and conventions (CITES, CBD...) for an equal profit sharing and in order to meet the local populations' daily needs.

**Goal 4:** To maintain ecological services for human well-being (water, clean air, carbon sequestration, availability of some forest resources).

**Goal 5:** To promote all parties to take responsible action through sincere collaboration to make information available in real time.

## D- RESTRICTIONS

### **Lack of Awareness:**

One of the most important restrictions identified during the consultation of the parties involved in the accomplishing of the vision is the people living in, or responsible for the mangement of, the sites were larely unaware about *M. aurantiaca*. They have no access research results because they are published in foreign languages and such reports are usually too technical. Furthermore, information, education and communication campaigns concerning the species have been insufficient. Thus, its endemism, conservation status, legal status, biology, ecology, are unknown to most of the parties involved.

### **Local populationss means of survival and producing:**

The majority of the local population living near the *M. aurantiaca* sites depends exclusively on traditional farming and earn low incomes. Thus, the transformation of suitable areas into farmlands (rice fields and food crop) is the first solution for their survival. However, because *M. aurantiaca* reproduction ponds and adjacent forests are ideal places for farming, a direct conflict exists. To date, there have been minial tangilble benefits to local people from forest conservation.

### **Lack of coordination between the parties involved**

The collaboration between scientists, the government and institutions working in conservation, exporters, collectors, and local communities, national and international pet farmers constitutes needs to be improved. Thus, a coordination system appears to be important so that the interventions at every level are in synergy.

## E- SPECIFIC GOALS, OBJECTIVES and ACTIVITIES

**Goal 1: To protect and restore the terrestrial and aquatic habitats essential for the species to maintain its genetic diversity, viable population size and ecological function within its current area of distribution.**

### ***Specific goal 1***

1. All *M. aurantiaca* sites are identified and adopt a type of active habitat management by 2015;
2. To establishing a monitoring system in every site in order to determine the abundance and threats to *M. aurantiaca* breeding sites by 2015;
3. To stop, or to monitor, illicit logging and mining in *M. aurantiaca* breeding sites within the Mangabe New Protected Areas by 2015;
4. The habitats in damaged sites are actively or passively restored, with the possibility of *M. aurantiaca* restocking in Mangabe, Torotorofotsy and Analabe.

**Objective 1: To establish protected areas to reduce pressure on *M. aurantiaca* natural habitats with a special focus on local livelihoods**

Specific Objectives	Actions	Deadlines (duration and/or frequency)
1-1 Participation of the local population in the conservation process and rational management of <i>M. aurantiaca</i> , habitats, especially protected areas by 2015.	1-1-1 Supporting the creation of community-based associations (VOI) for a management transfer of forests	5 years 2011-2015
	1-1-2 Integrated participation of the local population in the management, developing and establishing a management plan in every site and/or conservation area	5 years 2011-2015
	1-1-3 Local public consultation concerning the delimitation of the specific sites for the protection of <i>M. aurantiaca</i> in every conservation area	3 years 2011-2013
	1-1-4 Zonation in protected area management plans clearly signposted	3 years 2011-2013
	1-1-5 Establish a local monitoring structure	3 years 2011-2013
1-2 Produce, for each zone of occurrence, a clear management plan developed and accepted by all parties involved by 2015.	1-2-1 Applying a text that controls the delimitation of key sites	4 years 2012-2015
	1-2-2 Obtaining the final conservation status of the Mangabe New Protected Area.	3 years 2011-2013
	1-2-3 Conceiving a <i>M. aurantiaca</i> management plan in each area	3 years 2011-2013
	1-2-4 Validating with all parties involved, especially collectors, the current occupation zone of the species	twice 2011 and 2014

**Goal 2 : To preserve the scientific, economic, social and cultural values of the sites and to encourage their conservation.**

***Specifics goal 2***

1. The community-based associations in the new protected areas integrate activities favorable to amphibians into their dinas between 2011 to 2015.
2. Some *M. aurantiaca* sites located in new protected areas are included within strict conservation zones during 2012 to 2015.

**Goal 2: To apply the laws, regulations and references on forest, land and natural resources management and utilization with updates and improvement where possible**



Specific objectives	Actions	Deadlines (duration and/or frequency)
2-1 To support the local population in the management of <i>M. aurantiaca</i> and forests Mangabe and Torotorofotsy	2-1-1 Establishing/Update the <i>dinas</i> <sup>1</sup> to apply them according to the national law	5 years 2011 - 2015
2-2 To better integrate national texts on natural resources management and exploitation (Koloala, mining products, oil, water, land, ...) with international conventions and assessments	2-2-1 Information session in order to improve (if need be) the implementation of regulations by all parties involved	Once a year 2011 - 2015
	2-2-2 Establishing a committee for the follow-up of <i>M. aurantiaca</i> study reports and its habitat by the local community	2011
	2-2-3 Updating the status of the species: IUCN, ARKIVE, EDGE.	Every year 2011 - 2015

1 **Dina** : The Malagasy name of the social contract system, conceived and developed by the members of the local community, then accredited by the competent legal authorities to monitor the utilization of the natural resources in their area.

**Goal 3** :The direct and indirect rational exploitation of *M. aurantiaca* and its habitat is in agreement with local regulations, national legislation as well as international treaties and conventions for equal benefit sharing and to meet the daily needs of the local population.

***Specific goal 3***

1. To develop a sustainable and fair collecting system for frogs in some sites of the Mangabe forest from 2011 to 2015.
2. A legal land rational management of timber and non-timber products is applied in all *M. aurantiaca* breeding sites by 2015.

**Objective 3**: To improve the direct or indirect management and utilization of *Mantella aurantiaca* and its habitats for a better sharing of the benefits to local communities.

Specific Objectives	Actions	Deadlines (duration and/or frequency)
3-1 To improve management for an equal sharing of benefits in the chosen collecting areas	3-1-1 Setting an entrance fee, written in the DINA, in the frog collecting sites in Mangabe.	5 years 2011 - 2015
	3-1-2 Organizing collectors for locally implementing social and economic projects.	4 years 2011- 2015
3-2 To inform and communicate the economic importance of the rational management of <i>Mantella aurantiaca</i> and its habitat in every conservation area from 2011-2015.	3-2-1 Combat illegal collecting through setting a traceability process for frogs collected with gendarmes, mayors and VOIs	4 years 2011- 2014
	3-2-2 Supporting the VOI in Mangabe for the management of their forest through an annual verification of their remit.	5 years 2011- 2015
	3-2-3 To make the VOI of Mangabe and Torotorofotsy participate in the participative monitoring on conservation and collecting sites.	Twice a year 2011 - 2015
	3-2-4 Cost-advantage analysis and economic evaluation of the sector (based on the area: Torotorofotsy, Mangabe, Ambatovy, Analabe).	1 year 2013
	3-2-5 Evaluation of the biodiversity loss compensation and ecological functions because of economic activities in every area (Torotorofotsy, Mangabe, Ambatovy, Analabe).	4 years 2011- 2014
	3-2-6 Strengthening the responsibility of the "local committee of conservation" through organizing a yearly capacity building and assessment session.	5 years 2011 - 2015
	3-2-7 Settling and improving income generating activities within the Mangabe new protected area through payment projects for conservation	5 years 2011 - 2015
	3-2-8 Funding research, especially for carbon sequestration projects, that allows the local population's effective participation in the new protected area.	5 years 2011 - 2015

**Objective 4: To use best available science in a new strategy, accepted by the international communities and all the Malagasy stakeholders, for the legal and sustainable utilization of *Mantella aurantiaca*.**

Specific Objectives	Actions	Deadlines (duration and/or frequency)
4-1 To contribute to the professionalization of the sector from 2011 to 2015	4-1-1 Organization of yearly training sessions on the sector for the interested parties involved.	4 years 2011 - 2014
	4-1-2 Testing, evaluating and improving a new pilot system concerning collecting and initiating its application to other species	5 years 2012- 2015
	4-1-3 Carrying out a yearly assessment of <i>M. aurantiaca</i> and informing the CITES authorities.	5 years 2011 - 2015
	4-1-4 Looking for the means of controlling the sector through an integration policy for the benefit of all parties involved.	4 years 2011 - 2014
	4-1-5 Establishing a (pilot) commercial centre in order to promote the collaboration between exporters and the basic community	4 years 2012 - 2015

## Goal 4: To maintain ecological services for human well-being.

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### ***Specific goal 4***

1. To promote non-extractive benefits and avoid the deforestation in Mangabe and Torotorofotsy from 2012 to 2015.
2. The various types of ecological services are understood by the parties involved, especially the basic community from 2012 to 2015.

**Objective 5: To establish accessible communication tools, easy to handle and use, for the benefit of *Mantella aurantiaca* habitat conservation and to support education and information campaigns by the stakeholders.**

Specific Objectives	Actions	Deadlines (duration and/or frequency)
5-1 To support IEC (Information, Education, Communication) concerning the environment, at schools and in the villages in the Mangabe new protected area until 2015.	5-1-1 Setting a annual date for <i>M. aurantiaca</i> and integrate it into local social events in order to develop the species' profile and its conservation.	5 years 2011 - 2015
	5-1-2 Organizing activities to promote knowledge transfer for the profit of the biodiversity through <i>M. aurantiaca</i> .	3 years 2011 - 2013
	5-1-3 Providing instructions concerning <i>M. aurantiaca</i> and its habitat in primary schools.	3 years 2011 - 2013
	5 -1-4 Conceiving an easy identification tool for managers (custom, basic communities...) in order to distinguish similar species.	2 years 2011 - 2012

**Goal 5: To promote all parties to take responsible action through sincere collaboration to make information available in real time**

***Specific goals 5***

1. To communicate every year to the parties involved and the public the information on *M. aurantiaca* from 2011 to 2015.
2. To make sure that the measures conceived shall be applied and that in the case of unavoidable destruction of some sites, an overall improvement in the species conservstion status is made by 2015.

**Objective 6 : To disseminate research results and data to promiote share at a large diffusion the research and follow-up data, coming from the collaboration efforts between researchers serving as a decision tool for the parties involved.**



Specific Objectives	Actions	Deadlines (duration and/or frequency)
6-1 To continue surveying the distribution of <i>Mantella aurantiaca</i> until 2015.	6-1-1 Development of a national research plan and programme for <i>M. aurantiaca</i> .	2011 - 2012
	6-1-2 Identification and prioritisation of research and follow-up themes according to the needs.	2011
	6-1-3 <i>M. aurantiaca</i> genetic diversity study.	3 years 2011 - 2013
	6-1-4 Carrying out a long-term follow-up of climate change effects on <i>M. aurantiaca</i> and its habitats.	From 2012
	6-1-5 Organizing reflexion sessions for the carrying-out without prejudice of the research methods and collecting (number of specimens, means of conveyance,...).	Yearly session 2012-2014
6-2 To support the management authority of CITES Madagascar until 2015.	6-2-1 Sending to the CITES authorities of Madagascar the information on the wild populations, levels of collection and the populations in captivity in Madagascar or abroad.	5 years 2011 - 2015
	6-3-1 Competence exchange between the interested parties involved (zoos, parks, universities) for a pilot project in breeding in captivity.	2011 - 2013
6-3 To develop the possibility of a breeding in captivity and relocalisation programme until 2014.	6-3-2 All exporters try <i>Mantella aurantiaca</i> breeding in captivity, where necessary.	2013 - 2015
	6-3-3 Capitalizing research results for a management perspective (relocalisation and re introduction, etc.) and valorization (animals bred in captivity) for severely disturbed populations.	2014- 2015

6-4 To determine the exact yearly density/abundance of <i>M. aurantiaca</i> in the identified collecting sites from 2011 to 2015.	6-4-1 Determining the abundance of every known population	5 years 2011-2015
	6-4-2 Following up the population before and after collecting.	5 years 2011 - 2015
	6-4-3 Identifying the collecting period and sites without prejudice to the population of <i>M. aurantiaca</i> according to the scientific biological data.	Every year 2011 - 2015
6-5 To know the biology and reproduction mode of <i>M. aurantiaca</i>	6-5-1 Determining its biology and natural reproduction mode.	2 years 2011 -2012
	6-5-2 Carrying out a feasibility and trial study of re-introduction in restored sites around 2013.	2013 - 2014
6-6 To know the diseases that can threaten <i>M. aurantiaca</i>	6-6-1 Diagnosing diseases and their consequences	2011 - 2015
	6-6-2 Setting and applying a hygiene protocol in order to prevent the spreading of the diseases.	5 years 2011 - 2015

**Objective 7 : To encourage a close collaboration between researchers and collectors for a rational and sustainable utilization in the exploitation of *Mantella aurantiaca* and the protection of its habitat.**

Specific Objectives	Actions	Deadlines (duration and/or frequency)
7-1 Mutual collaboration between the actors until 2015	7-1-1 Establishing a <i>M. aurantiaca</i> network and developing a close link between the authorities at the district level, the CITES authorities, the university, the collectors, operators, parks, site managers, land monitoring agents and the other parties involved.	5 years 2011 - 2015
	7-1-2 Exchange and sharing, as soon as possible, of knowledge, data, competence and news.	5 years 2011 - 2015
	7-1-3 Organize an annual restitution session	5 years 2011 - 2015
7-2 Capitalization of all acquired knowledge	7-2-1 Transferring and sharing periodically knowledge with the authorities and managers.	every 2 years 2013 - 2015
	7-2-2 Giving the opportunity to the Malagasy zoo technicians and students to learn the technique necessary for the breeding in captivity and to carry out ex-situ research on <i>M. aurantiaca</i> .	2011 - 2015
	7-2-3 Conception of a data collection, texts and reports concerning <i>M. aurantiaca</i> , its habitat and the sector.	Every 2 years 2011 - 2015

## F- Participants

Parties involved	Name
Direction Générale de l'Environnement et des Forêts (Direction de la Conservation de la Biodiversité et du Système des Aires Protégées) et Direction de la Valorisation des Ressources Naturelles), CITES Madagascar Management Body	RASOAVAHINY Laurette RABESIHANAKA Sahondra RANDRIAMAHALEO Sahoby RAZAFINDRATSIMBA Véronique RAHAINGONDRAHETY Volana Nasolo
CITES fauna Scientific Authorities And the Department of Animal Biology, University of Antananarivo	Dr RAKOTONDRAVONY Daniel Dr RASELIMANANA Achille RAVAOARIMALALA Attale
District of Moramanga	MASO Marcelin
Ambohibary Commune	RANDRIAMAHADERA Noelison
Mangarivotra Commune	RAKOTOVELO
Chef Fokontany (Mankana, Beparasy, Antsily, Andranomandry and Lakambato)	RANARIJAONA Henri RABEARIVELO Gabriel RAKOTOMAZAVA Jean Paul JEAN Felixon RAKOTONDRASOA Justin
CIREF, Moramanga	RAZAFINDRAHANTA Hanitriniaina
CFOR, Moramanga	RAKOTONDRAMASY Jules
Langaha Association	RABEMANAJARA Falitiana
Office National pour l'Environnement (National Office for the Environment) Moramanga	RAZAFINDRANDIMBY Jaques
Office Régionale du Tourisme (Tourism Regional Office), Alaotra Mangoro	RAVAHINIMBOLA Rachel
Madagascar National Parks Andasibe- Mantadia	RAMANAKIRIJA Hery
Parc Botanique et Zoologique de Tsimbazaza	RANDRIANIRINA Jasmin
Operators, exporters and "captivity" farmers	FANJAVA Marie Yannich RAMBILISON Miot FOUILLETTE Arnaud RAZAFINJATOVO Roger DONTY Roberto

CSA, Moramanga	RAKOTONIRINA Albert
Fédération des Communautés de Base Miara-dia (Community-based Federation)	ANDRIANAVALONA Lalaina
Vondron’Olona Ifotony (VOI)	RAKOTOARISOA Emile (VOI FITAHIANA) RAKOTOHAMBANA Fidimanana (VOI TARATRA) RAKOTONDRANIRY Félix (VOI FANIRY) RANDRIANANTOANDRO (VOI FANIRY) RANDRIATSIHETY (VOI MIARA-MIRINDRA) RAVELOSON (VOI MIARA-MIRINDRA) RAZAFINDRABE Jaques (VOI MIARA-MIRINDRA) RASOAZANANY Perline (VOI SOAMIA-FARA) RAVAOARIVONJY Juliette (VOI MAHASOA) RAZANAKOTO Julien (VOI HAFASAHONA)
Private Owners and notables	RABOTOVAVY Vincent RANDRIANAHINA RAKOTONDRASOA
Ambatovy Project	ANDRIANAIVOMAHEFA Paul RAKOTOMANGA Barson DICKINSON Steven MASS Vanessa
Man And The Environment	ANDRIANANJA Tsaritsamamy
Plate-forme pour la gestion du Corridor Ankeniheny –Zahamena (PLACAZ) (Platform for the Management of Ankeniheny-Zahamena Corridor)	RANDRIANALISON Gervais
Conservation International	RANDRIANASOLO Harison
Amphibian Specialist Group	ANDRIAMAHAZO Herilala RABIBISOA Nirhy
Mitsinjo Association	ANDRIAMIARY Jean Noel

Local collectors	SARARICASKI LEZIANY LAMBERT Donatien RANDRIANANTENAINA Gilbertho RANDRIANASOLO Gilbert
Madagasikara Voakajy	RANDRIANANTOANDRO Christian RANDRIANAVELONA Roma RAZAFIMAHATRATRA Bertrand RALAIARIMALALA Sylvain TOLOJANAHARY Nandinanjakana ANDRIATSIMANARILAFY Raphali RAKOTOMBOAVONJY Victor TEFIMANANA

#### G- List of the meetings organized

Meeting	Date and place
Meeting for consulting all the interested parties involved and developing the strategy	August 25, 26, 2009, Moramanga
Meeting for consulting operators	November 11, 2009, Antananarivo
Working session for a restricted group for the preparation of the validation of the strategy	November 25, 2009, Antananarivo May 20, 2010, Antananarivo August 5, 2010, Antananarivo September, 2010, Antananarivo and January 20, 2011, Antananarivo.

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