Background Summary
The Center for Conservation in Madagascar is one of the original Centers of the Saint Louis Zoo WildCare Institute. The Center’s primary goal is to reduce direct pressures on Madagascar’s threatened and endangered species. To achieve this goal, the Saint Louis Zoo works through a consortium known as the Madagascar Fauna and Flora Group (MFG). The MFG was founded on the principle that uniting individual institutions under one umbrella significantly increases the contribution any one facility can make on its own. The MFG is an international, non-governmental organization comprised of zoos, aquaria, universities and other conservation organizations. As a collective body, it works with Madagascar government authorities and in-country staff to achieve conservation action, research, capacity building and education efforts in eastern Madagascar.

The Saint Louis Zoo was a founding member of the MFG and has been committed to wildlife conservation efforts in Madagascar since the late 1980s, with the earliest efforts focused on conservation research and wildlife recovery efforts of lemur species. Lisa Kelley, Ph.D., the Executive Director of the WildCare Institute, serves as the Director of this Center. She also serves as Secretary on the MFG Executive Board. Bob Merz, Assistant Director of the WildCare Institute, is the Assistant Director of this Center.

In-Country Location
The Center supports efforts at both of the Madagascar Fauna and Flora Group’s primary conservation research sites, Parc Ivoloina and Betampona Natural Reserve. Both sites are located in Eastern Madagascar (Fig. 1).

- Parc Ivoloina is a former forestry station that has been transformed into a 282-hectare conservation education, research and training center. Located just 30 minutes north of Tamatave, Parc Ivoloina also is home to a four-hectare zoo for native wildlife. Aside from Parc Ivoloina, Madagascar only has one other zoo.

- Designated as a reserve in 1927, Betampona Natural Reserve is Madagascar’s oldest protected area. It is a 2,228-hectare rainforest fragment that contains high levels of plant and animal diversity. MFG’s continual research presence has protected Betampona from large-scale habitat loss and degradation despite the fact that it is surrounded on all sides by village activity. In fact, research completed in 2021 through Saint Louis University’s Geospatial Institute confirmed that the decades of Zoo-sponsored conservation work at Betampona Natural Park in Madagascar has paid off.
Forest coverage at Betampona has increased by 28% in the mixed forest category and a remarkable 59% in the evergreen forest category (Figure 2). This is only one of two reserves in Madagascar where forest coverage has actually increased in recent years.

**Land cover types of Betampona Nature Reserve and surrounding areas, Madagascar**

Figure 2: GIS Illustration of 10 year forest growth at Betampona Natural Reserve, both in total area and in forest type.

**Center Approach**

The Center's goal to reduce direct pressures on Madagascar's threatened and endangered species is approached primarily through the four objectives of the Madagascar Fauna and Flora Group. These objectives are:

1. Conservation action to reduce or remove direct threats and maintain or build viable habitat
2. Building in-country research capacity, leadership and/or management
3. Conducting research that informs conservation management needs and/or methods
4. Community development with a focus on both local communities and local and national authorities

**2022 Major Accolades and Accomplishments**

Through funding provided by the Saint Louis Zoo Wildcare Institute, Jacksonville Zoo and Ambatovy (a major industrial mining company), major renovations were made on five of Parc Ivoloina's lemur habitats. In the fall of 2023, Facility Management and Primate staff from our Zoo will go to Ivoloina to make further renovations, bring much needed tools to the Parc, and train staff to build capacity in building and renovation work.

Through funding provided by the Wildcare Institute Field Research for Conservation Grant program, four additional new frogs from Betampona and Parc Ivoloina were described in 2022. To date 16 new frog species in total have been described for Betampona. A further staggering 24 amphibian species and 20 reptile species new to science have been confirmed for Betampona and Parc Ivoloina through this same work but have yet to be formally described.

**Newly renovated enclosure made possible in part through Saint Louis Zoo WildCare Institute Emergency Funding.**

**Newly described frog species at Betampona (Grephyromantis portonae), named after MFG’s Vice Chair of Conservation and Research, Ingrid Porton.**
Through the Living Earth Collaborative (LEC) project, over 25,000 native trees are being produced in MFG’s dedicated plant nursery. Over 14,000 of these trees have already been planted in 101 restoration plots totaling 8.9 ha. The areas targeted for restoration are those in the main core of Betampona’s critically endangered black and white ruffed lemur and diademed sifaka territories.

Center Impact

The Center continues to evaluate the impact of two signature projects that began in 2018.

**Project 1: Genetic Management Translocation Project of the Diademed Sifaka**

Since 2018, MFG team members have been conducting several missions to capture and collar the existing groups of the critically endangered lemur, the diademed sifaka, in Betampona Natural Park. Since 2020, the team has studied five of the groups, despite a short interruption due to the pandemic. To date, 10 groups have been identified (Figure 3).

The most current known compositions of the groups are as follows:

- **Group 1:** was comprised of adult pair and offspring in 2020 and again in 2021. The 2021 offspring died at 3 months. In 2022, the 2020 offspring and adult female died – likely due to fossa predation.
- **Group 2:** was comprised of an adult pair and a 4 year-old daughter who dispersed from her natal group in December 2021. She paired with an adult male to form Group 9. However, the young female disappeared in Sept 2022 and is presumed dead. This female’s 2021 offspring died in 2022.
- **Group 3:** was comprised of an adult pair and an infant born in 2021. The infant died at 3 months.
- **Group 4:** is comprised of a single male
- **Group 5:** is comprised of a single male that was radio-collared in 2019. He was last seen in March 2021.
- **Group 6:** is comprised of an adult pair and an adult
daughter. An infant born in 2022 died.

» Group 9: is comprised of an adult male.

» Group 10: Is the newest group that has been discovered. It is comprised of an adult male and an adult female.

In addition to the behavioral observations, the Zoo has partnered with Dr. Emily Wroblewski, an anthropological geneticist at Washington University, to assess the population’s genetic diversity. Based on the analyses, we estimate that Betampona’s diademed sifaka have likely been isolated for at least seven generations. Additional samples will be genotyped in 2023.

While behavioral and genetic data confirm the need for increased gene flow among this population, there have been multiple delays to the timing of the translocation. The first significant delay is the change in leadership at Ambatovy, the mining company that manages the nearby forest with the targeted diademed sifaka donor population. A letter of support from Ambatovy is required before a permit application can be submitted to the Ministry of the Environment. The second delay has been caused by a 2022 publication titled Nuclear and Mitochondrial Phylogenomics of the Sifakas Reveal Cryptic Variation in the Diademed Sifaka. The results from the study described in the publication identify genetic differences between northern and southern diademed sifaka that may warrant distinguishing the populations at a subspecies or species level. These findings necessitate further genetic analysis of the Betampona population, and to that end we are collaborating with the publication’s senior author. The results will determine the clade from which to select potential translocation candidates, as the Ambatovy population appears to be of a different clade despite its relatively close proximity to Betampona.

Plans for the future:
The Saint Louis Zoo remains committed to the translocation of the diademed sifaka as a priority species despite the indication that the diademed sifaka population is at critically low numbers with a high mortality rate. While the diademed sifaka population at Betampona is critically low, this critically endangered species is at risk throughout the country, and resides in few well protected areas. Moreover, this species does not do well in human care, which means there is no assurance population in zoos. There is hope that with a translocation, gene flow will occur through the births of offspring that survive and thrive. However, these recent findings highlight the need to determine the causes of high mortality within the current population. See Stories from the Field below to learn more about how we plan to further study this population.

“Kissing” diademed sifaka in Betampona Natural Reserve.
**Project 2: Newcastle Vaccination Poultry Project**

An important vulnerability associated with poultry farming in rural Madagascar is the array of pathogens to which the species is susceptible, including Newcastle disease (ND), causing outbreaks with mortality rates above 70% in unvaccinated flocks.

In 2018, Madagascar Fauna and Flora Group (MFG) initiated a project providing free vaccinations against ND for chickens in 12 villages around the Betampona Natural Reserve (covering almost 700 households). The goal of this project has been to protect poultry from this devastating pathogen and improve availability of protein in family diets as well as villagers’ livelihoods, thereby reducing the pressure on wild animals in the forest. Throughout the project, demographic data have been collected for each participating household, which has allowed us to measure and show the positive impact of this project on chicken ownership and human livelihoods. In fact, participating households owned on average 12.4 more chickens and reported a 55% decrease in chicken losses due to ND than they did before the beginning of the project, which surpassed the initial objective of this program.

The year 2021 marked the end of the support from the IUCN SOS Save the Lemur grant that provided these free vaccinations. An evaluation survey that encompassed participating and non-participating households was then carried out in order to assess people’s perception with regards to the program. This evaluation further highlighted the impact of the program and showed that participating households were much less likely (approximately 70 times less likely) to have sustained a ND outbreak in their flock during the previous year. Nevertheless, only half of the participating households perceived that their flock actually grew during the program.

**Plans for the future:**

Despite additional funding to lower the costs and thereby ease the transition, household participation dropped considerably. The pandemic led to significant economic hardships, especially for the rural poor. We believe this issue will require one or more skilled and empathetic people who can carry out meaningful conversations with households that participated in the program. A deeper understanding of the bigger picture could help in developing a path forward. It is possible this project will not continue in 2023.

**Invasive Species Projects**

Dr. Karen Freeman, Executive Director of the MFG, will continue to oversee several key invasive species management projects important for the Center. These include:

- Completion of the removal of invasive plants and the replanting with endemic trees from the 10 hectares of critical lemur habitat in Betampona. As mentioned above, 8.9 of the 10 hectare goal has already been accomplished. The project is likely to meet its goal to complete this project by end of 2023.
A community-based invasive species surveillance and reporting network around Tamatave. This year marked the first year that the surveillance network became fully functioning. This network has already provided critical information, particularly on the distribution of the highly invasive Asian toad. In a single year, two new satellite toad populations have been identified, which will now be targeted for rapid toad control and mitigation efforts.

Working with the Ministry of the Environment and Sustainable Development in Madagascar to uphold the IUCN’s 2020 resolution #116 to increase capacity for invasive species management in Madagascar. Progress has been slower than hoped for at the national level in this regard due to multiple changes of the Minister and top directors of the Ministry of the Environment and Sustainable Development (MEDD). However, significant progress has been made at the regional level with strong support being gained by the Governor of the Atsinanana Region, the local Director of MEDD- Atsinanana and other local authorities. There has been initial dialogue with the Tamatave port authorities to start developing basic biosecurity protocols for the port.

Stories from the Field
From Dr. Fidy Rasambainarivo, Affiliate Scientist of the WildCare Institute

I am excited to announce that starting in August 2023, I will join the faculty at the Biology Department of East Carolina University, Greenville, North Carolina as an Assistant Professor with a focus on Disease Ecology. My research program will characterize patterns of health and disease transmission at the human, domestic animal and wildlife interface in order to inform conservation and public health policies by using fieldwork, molecular techniques and computational models. My training as a wildlife veterinarian, epidemiologist and disease ecologist makes me particularly suited to address questions related to the ecology of infectious diseases while contributing to biodiversity conservation and public health in general. In future work, I intend to expand my research to understand the role of anthropogenic changes on the dynamics of infectious diseases and quantify their effects on biodiversity.

My first research objective is to continue and expand the Prosimian Biomedical Survey Project that was initiated by the Saint Louis Zoo in 2000. A critical knowledge gap for many species of conservation concern is reference baseline biomedical values. As an example, in many wild animal species in Madagascar, basic blood analysis values are missing. Yet, such measurement is essential to answer critical yet simple questions including: “What is a healthy lemur/fossa?” and “How does the increased interactions with humans and their domestic animals affect the health of lemurs/fossas?”. Collectively, results from my work over the last decade have driven a series of advances in field and laboratory based measurement of baseline characteristics of the fauna of Madagascar and pathogens that are transmitted across species. Specifically, in collaboration with other researchers, I will establish and maintain long term field studies at multiple protected areas in Madagascar (Betampona Natural Reserve, Ranomafana National Park [Mangevo], Kirindy Mitea National Park and Tsinjoarivo Special Reserve) where I will evaluate the health of mammalian wildlife longitudinally and across a gradient of habitat degradation.

Secondly, I aim to expand my research on the “One Health” concept and further our understanding of the multiple interactions between anthropogenic changes and the health of humans, domestic animals and wildlife. Not only will the changes in land-use affect populations’ exposure to diseases but it is also expected to have a complex array of effects on individuals’ defenses against diseases. Habitat fragmentation is disrupting animals’ natural dispersal behavior and may lead to inbreeding depression on the one hand, and the restricted space and resources within fragments may lead to chronic stress, malnutrition and reduced immune function on the other hand. Building on a growing dataset of lemur and carnivore health information in Madagascar and available resources (Genomics core and sequencing facilities at ECU and Mahaliana Labs in Madagascar), my research will address the following question:
How does the changing habitat and access to resources affect disease susceptibility? In particular, by incorporating results from genetic analysis, pathogen exposure and disease manifestation, I will assess the impacts of habitat fragmentation on genetic diversity, immunity and disease susceptibility on the endemic fauna of Madagascar.

In conclusion, my research program will build upon two decades of research, understanding the transmission of pathogens between humans, domestic animals and wildlife in Madagascar to advance conservation. Although I will be based in North America, I remain committed to conserving my native Madagascar’s biodiversity by conducting rigorous science while simultaneously promoting local scientific development, education and capacity building. To that end and thanks to the support of the Saint Louis Zoo WildCare Institute, I have set up Mahaliana Labs in 2018, which is a unique molecular diagnostic laboratory and training center in Madagascar to facilitate research on the “One Health” concept and conservation medicine. This all falls under the umbrella of using an ecological lens to understand the impact of pathogens with implications for biodiversity conservation and human health. Today, Mahaliana is used by students and researchers from Madagascar and all around the world (including the Saint Louis Zoo) to answer scientific questions of conservation relevance and using tools that were previously inaccessible in Madagascar. Through my new position at East Carolina University, I will continue to maintain Mahaliana Labs and expand its capabilities and continue mentoring and building the capacity of Malagasy scientists.

2022 Publications
Below are published results from projects that were supported, at least in part, through WildCare Institute funding (primarily through our Field Research for Conservation grant program). All of the 2022 publications are from the work of the herpetology team who are mentioned in the 2022 Major Accolades and Accomplishments section.


2022 Center Budget Allocation
Since its inception, a majority of this Center’s budget has been dedicated to the MFG. The Saint Louis Zoo is a platinum member of this organization. In addition to general operations, funding went towards:

» Research and Restoration efforts, including funding for the salaries of Forest Agents and Research Assistants ($44,000)

» Capacity Building, which includes in-country university support at the Master’s degree level, local authority training, and MFG staff training ($19,000)

» Partial salary support for Karen’s position as the Executive Director of the MFG ($42,000).

» In addition, we provided support for Fidy’s biomedical research, which is outside of MFG funding ($23,000). We have supported this research since 2018.

» Last, Dr. Crottini is the Principal Investigator for a Field Research for Conservation grant, that was awarded in 2022. The title of the project is “Investigating direct and indirect effects of the Asian toad (Duttaphrynus melanostictus) invasion on native herpetofaunal communities of forest fragments in eastern Madagascar ($9,965).

» In sum, the WildCare Institute dedicated $129,965 for conservation efforts in Madagascar in 2022.