THE MACARTHUR FOUNDATION FUNDS STUDY ON IMPACTS OF CLIMATE CHANGE IN MADAGASCAR

THE EFFECTS OF GLOBAL CLIMATE CHANGE ON THE PLANTS OF MADAGASCAR: DETECTING CHANGES, PROJECTING IMPACTS, AND DEVELOPING RESPONSES

There is broad consensus that human-caused global warming will result in significant changes to the Earth's climate regime, and that these changes will in turn have major ecological consequences for our planet's biodiversity. However, the magnitude, timing and probable impacts of these changes are not yet well understood. Within Madagascar, a globally recognized biodiversity hotspot and a priority area for conservation, it is now becoming clear that decades of effort and hundreds of millions of dollars of investment in support of protection and sustainable management of natural resources will be severely compromised if the Malagasy biota is unable to adapt to and survive the dramatic changes in climate now being projected. It is thus imperative to develop the means to detect and measure changes as they are taking place, and then analyze the resulting data using appropriate climate change models to project future impacts on Madagascar's biodiversity. In parallel, an effort must also begin immediately to identify and test field-based activities designed to mitigate or limit these projected impacts.

The Missouri Botanical Garden, with nearly 35 years of experience working in Madagascar, has just been awarded a 3-year grant from the John D. and Catherine T. MacArthur Foundation that will enable us to play a leading role in addressing key issues that relate to understanding and dealing with the impacts of climate change on this island's remarkable biodiversity. With the Foundation's support, we will:

1. *Establish a series of low-maintenance, long-term monitoring sites at carefully selected localities to detect and document impacts on Madagascar's flora and vegetation resulting from global climate change.*

Plants will respond to climate change in a variety of ways – migration into new habitats, local adaptation, or even extinction – and it will be important to assess the relative importance of these responses in order to evaluate the likely impacts on biodiversity. We will set up monitoring at sites primarily in southern Madagascar (where models predict the most pronounced shifts in climate) to track local changes in phenology, abundance/mortality, and habitat tracking along steep environmental/habitat gradients. Local responses are expected to be most evident in extreme environments where plants have adapted to especially severe and marginal conditions, and also at species' range boundaries, where response dynamics to climate change will be more marked than within the interior of their ranges.

2. *Use environmental niche modeling to project the future suitable habitats for a robust sample of endemic plant species under various climate change scenarios, and then estimate the likely consequences for biodiversity, identifying key migration paths and refuge areas that must be protected.*

Using a carefully selected sample of plant species distribution records compiled over the last several decades, will will estimate future potential distribution areas of suitable habitat under various climate change scenarios, and compare these with the current remaining cover of native vegetation to identify key corridors whose maintenance and protection will be critical for ensuring that essential migration routes remain intact. We will also identify localized ecosystems that are the most vulnerable in the face of climate change. Our modeling studies will help us understand the ways in which plant communities are likely to change in the future and will provide invaluable guidance for identifying the most important areas for protection and restoration.

3. *Develop a pilot study to test ecological restoration techniques, implementing a suite of activities to bridge habitat gaps across an environmental gradient, and thereby (re-)establish corridors to facilitate species migration in response to climate change.*

Madagascar's native vegetation is now highly fragmented, with much of it reduced to islands in a sea of anthropogenic grassland, and this has serious implications for the capacity of Madagascar's biota to adapt to climate change. Species lacking the means to move between islands of forest or adapt to changing local conditions will be unable to track climatic shifts and are likely to perish when they are trapped in isolated areas where conditions become progressively less suitable for their survival. It will therefore be necessary to establish bridges between fragments of suitable vegetation to prevent this, but at present we know very little about the steps required to do this create effective bridges in Madagascar. In conjunction with the planned monitoring work, we will develop and test techniques using the principles of ecological restoration so that they can be used to ensure connectivity at high priority sites throughout the country.

4. *Summarize the results and findings of the studies listed above in easily understandable written reports and accompanying visual aids, along with a series of oral presentations and workshops, and collaborate with partner organizations to inform key decision-makers (including government officials) of the likely impacts of climate change on Madagascar's plant diversity.*

Timely action in the face of climate change will only be possible if reliable information and sound recommendations is available. As results from our work become available, we will prepare and disseminate a comprehensive vulnerability and adaptation assessment of the potential impacts of climate change on the flora and vegetation of Madagascar. This will help guide policy and decisions made within the country, and will provide effective tools for Madagascar to advocate action in international forums, highlighting the consequences of climate change on the planet's most important biodiversity hotspots.