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Forests for Lemurs:
An Ecological Restoration Dilemma

by

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The Dilemma*

Dr. Nirina Andrianasolo entered the room. Everyone was waiting for her to start the monthly meeting of the board of directors for the Alan'ny Varika (pronounced "*Ah*-lahn-nee *Vah*-ree-cah") Reserve. Nirina, executive director of the board, was a primatologist passionate about wildlife conservation and had led the reserve's work for the past three years. The Alan'ny Varika Reserve was a globally renowned private forest reserve for Madagascar wildlife. Being the reserve manager was Nirina's dream job, and she believed firmly, as did the Rakotobe family (owners and board members of the Alan'ny Varika Reserve), in the importance of conserving Madagascar's forests and their most iconic inhabitants, the lemurs.

The first board member to greet her was Tanjona Rakotobe, the oldest brother. He had the challenging responsibility of managing Alan'ny Varika's finances. It had not been the best year for the reserve. The number of visitors had declined, affecting one of their main income sources: ecotourism. Louis and Anne Rakotobe, his parents and Alan'ny Varika's founders, were sitting next to him. At the head of the table was Sylvie Rakotobe, his younger sister, who knew that Nirina was going to share some good news about potential funding to restore a large portion of the reserve.

Nirina called everyone to order. "Following the agenda, we will start with our main topic of today's meeting: the Dabney Foundation Grant. These grants fund conservation projects of global importance and, as you may recall, we submitted a preliminary proposal two months ago. I was contacted yesterday by Jean Dubois, the Dabney Foundation Director, who informed me that we are a finalist. They received 450 grant applications this year, and we are one of only ten selected for full proposal consideration."

"That's great news," said Tanjona. "Receiving this grant could really help us financially in the short-term and improve the reserve over the long-term. Reforesting those 400 hectares that are currently in pastures would greatly increase the amount of habitat Alan'ny Varika provides for lemurs."

Nirina continued, "Yes. Although funding is not guaranteed, our chances are good. The foundation requires finalists to provide more extensive and in-depth information for full proposals. Most importantly, we need to include a detailed restoration plan, which I have begun to work on. Today, I would like to summarize our options, discuss the merits of each, and hopefully reach a consensus on which alternative we will propose to the Dabney Foundation."

"Please, go ahead," said Louis Rakotobe.

"Well," Nirina continued, "the restoration plan for the grant has to include a detailed planting scheme that shows how many individuals from each tree species we would like to plant and where we intend to plant them. My initial thought

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* This case study is based on an actual reserve located in the south of Madagascar. However, the name of the reserve as well as the names of all individuals associated with the reserve have been modified.

was to rely mostly on fast-growing non-native tree species like kilimbazaha or acacia,* as we did ten years ago to restore the forest in the northern reserve unit. However, we may want to reconsider whether we should be planting non-native tree species in the reserve."

"Why shouldn't we use non-native species again?" asked Tanjona. "They established quickly and grew fast. I've seen lemurs eating those plants voraciously. We need to demonstrate to our donors that we know how to grow a forest, and we've done it in the past with non-natives. Why change that now?"

"Planting both natives and non-natives was our original approach," Nirina explained, "and that is why we have continued to grow non-native seedlings in the nursery. But Sylvie and I have been reading more about these introduced species, and it seems that there are some reasons to consider only native species for our forest restoration.

"We could either plant a mix of native and non-native species, or we could choose to use only native species. There are advantages and disadvantages to each approach, which is what we need to consider. I know that we are all here for the best interest of the reserve. We all love this place, and we all want to protect it and conserve it. What I would like us to do today as a group is to reflect on those advantages and disadvantages and agree on one option. You know this reserve better than I do," Nirina said as she moved to the whiteboard in front of the room to capture the board's ideas from what was likely to be a complex debate. "Your opinions on this matter are crucial to guide this grant proposal, and ultimately for the future of this reserve. Therefore, I'd like to hear your opinions in favor of using non-native species as part of our species mix. Mr. Rakotobe, would you like to start?"

"Yes," Mr. Rakotobe replied. "When we planted the non-native trees in the northern area, we did it for the lemurs. After a long drought, almost 30% of all the existing native trees in that area had died and the lemurs lacked food. Our neighbors gave us seed from the non-native trees they had planted in their forests because those non-natives were growing well and fast on their property. The lemurs needed food and those trees provided it. They've been feeding from those fruits for the past ten years. If that worked in the past, I think it can also work now."

"I remember that situation," said Tanjona. "Conflict over food between the ring-tailed and brown lemurs was problematic. The populations of both lemur species were growing, and food scarcity caused fighting among groups of lemurs. The conflicts led to severe injuries and even a few deaths. If the tree plantings hadn't been so successful, I'm not sure what would have happened to the lemur populations in the reserve."

"I would like to add," interjected Mrs. Rakotobe, "that our neighbors always complained about how slowly native trees grow in the open areas compared to the non-native species. They needed the forest to quickly establish and protect the bare soil from eroding over large areas on their property. Where they planted the introduced tree species, the forest grew quickly and is very nice. The situation here in Alan'ny Varika is similar. We have extensive areas with bare, dry soils. We need to increase the forest cover rapidly as well as provide lemurs with enough food. Perhaps the only way to do that is with introduced species. They do grow fast."

"Any other thoughts about other benefits of non-native plants for this restoration project?" asked Nirina, pointing to her list on the whiteboard.

"I'd like to point out some financial considerations," said Sylvie. "As you all know, for the past four years we've been growing plants in the nursery for the two restoration sites. We've primarily collected seeds in the reserve from the native trees like the kily, bemavo, and sasavy, but we've also collected seeds from the non-native trees that were planted here ten years ago, like the kilimbazaha and the varogasy.† We've had more success growing the non-native species in the nursery."

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* The plant names used in the text are the local names. The kilimbazaha *(Pithecellobium dulce)* is a tree native to Central and Northern South America, and the acacia *(Acacia mangium)* is a widely planted species native to Australia, Papua New Guinea, and Indonesia.

† Kily *(Tamarindus indica)* is a tree native to India and Madagascar, now cultivated around the tropics; bemavo *(Celtis bifida)* and sasavy *(Salvadora angustifolia)* are endemic to Madagascar; kilimbazaha *(Pithecellobium dulce)* is a tree native to Central and Northern South America; varogasy *(Cordia caffra)* is a tree native to Mozambique.

Sylvie continued, "Nirina, please correct me if I'm wrong, but a lot of the natives have died in the nursery. They require more maintenance than the non-natives. We must consider the higher costs of relying on native species for the restoration. We may need to hire more people for the nursery, and perhaps even double our efforts."

"You're right, Sylvie," affirmed Nirina. "Seedlings of native tree species have had lower survival rates. We still need to learn a lot about how to propagate and grow the native species because they haven't previously been commercially produced. That is a major challenge. According to my calculations, if we use a 50:50 mix of natives and non-natives, we could restore an area twice as big as if we used only native species."

"Why?" asked Mr. Rakotobe

"Because of the cost," Nirina replied. "Non-natives have been easier to propagate in our nursery and they are rarely affected by pests. Less labor and maintenance in the field is required. They don't need a lot of water and they are very resistant to drought, so that means that we don't need to replace dead trees in the field."

"I think it's a really important point to consider. Our restoration area would be larger and that might make our grant proposal more compelling for the foundation to fund," said Tanjona.

"But we also need to consider other aspects of using non-native species," said Nirina. "I think we have a good list of reasons to include non-native species for our restoration project. Now, let's consider some of the disadvantages of this approach. Would anyone like to start?"

"Well," replied Sylvie, "there are many unintended consequences when non-native plants are used for restoration. Some become invasive."

"But none of the ones we've planted has become invasive," said Sylvie.

"Not yet," said Tanjona. "But I heard Nirina complaining about how small neem trees are found everywhere in the forest. They are considered to be a weed in some places."

"Yes! In fact, I had that topic on our agenda for today's meeting," said Nirina. "The neem trees that we only planted in the southern area are now in their adult stage, and apparently they've been spreading and establishing successfully in other parts of the forest. I assigned a team to start removing all those seedlings. They seem to be taking over. I've read research papers reporting that non-native species do not necessarily become invasive right away."

"And we have had problems with invasive plants in the reserve. We've had to fight hard against that invasive Cissus vine," completed Tanjona. "Removing those vines from the forest has required a lot of staff time and has cost us a small fortune."

Nirina couldn't agree more. She had dedicated her first two years in the reserve to the eradication of *Cissus quadrangularis* from the forest. "Cissus is a vine, so it grows rapidly. The non-native trees in Alan'ny Varika don't seem to be taking over. However, I have noticed that non-native tree seedlings are very common in the forest now; much more abundant than seedlings of the native trees. So I think there is a risk that they may become dominant in the forest, outcompeting the native species. And what about other risks, like those introduced tree species being toxic? In a reserve where I previously worked, we had to remove neem trees because their fruits were toxic to the resident chameleons."

"You're raising a good point," said Anne. "We had a similar problem here, too. We planted a beautiful tree from Central America in several places on the reserve. Lemurs got sick from eating its leaves. Years later, we had to spend a lot of money removing it from the reserve."

"Yes, the leucaena tree!"* Sylvie interjected, as she searched for old photos on her phone to share with other board members. "It was Haruto, the Japanese lemur expert, who came to the reserve and found that the leucaena was causing lemur hair loss. Poor things, they looked so bad. Haruto recommended that we remove all the stands of leucaena from the reserve."

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* Leucaena *(Leucaena leucocephala)* is a legume tree native to Central America.

"I would like to add something else to our list of concerns," said Mr. Rakotobe. "Lemurs are at the heart of everything in this reserve. However, people also visit us to observe our endemic plant species. Those native plants also attract tourists, who come to visit our forests because they can't be found elsewhere on this planet."

Nirina looked at all the notes she had made on the whiteboard. She was pleased with the great discussion during the meeting. The board members had provided helpful input on the advantages and disadvantages of using non-native trees in the reserve. She thought it was a good time to conclude this part of the meeting.

"Thank you all for these wonderful contributions. I think we have a good list to consider for this decision. Does anyone want to add anything else?"

"I would," said Sylvie. "This foundation expects accountability from the groups they financially support. The Dabney Foundation is well known for their high standards for project monitoring. If we get this grant, we will have an opportunity to request funds for a second project phase in four years, which could double our restoration funding. But that possibility is contingent upon our results and our commitment to achieving the goals that we propose in this first phase. Whatever we write in this plan, we have to be committed to it during the next four years and it will need to be successful."

"And that's why we need to lay out a good plan in our proposal and hopefully secure the grant funding to restore lemurs' forest habitat," added Tanjona.

Nirina felt she had a great responsibility on her shoulders. "This is a hard decision to make," she said. "I would like to think about this more carefully. Many important points have been raised in this meeting, but we still have more things on the agenda. If everyone agrees, I would like to review your comments more after the meeting, try to think about other issues as well, and weigh the options. I'll share my recommendation with you in a few days. This is a time-sensitive matter, so I know I have to make a decision soon."

"Yes, Nirina" replied Mrs. Rakotobe. "We will wait for your recommendation, and we will schedule a special meeting next week to make a final decision. We believe in your good judgment and your criteria. I am confident that whatever you suggest is what we will do."

Nirina had a lot of information to weigh and think about. This was not an easy decision, and she had the tremendous task of making a decision that would impact the future of the forests and the lemurs in Alan'ny Varika.

Your Turn

If you were Nirina, what would be your plan for the reserve? Do you recommend restoring forests using only native species or do you recommend using a mix of native and non-native ones? What are your main reasons for this recommendation? What problems could arise if your choice is implemented and how would you address these issues?

Use the following questions to check your understanding of the case and to guide your discussion of the different restoration options described in the case.

Questions

1. What is an endemic species?
2. What happens if endemic species are lost?
3. How many species of lemurs are there and what is their conservation status according to the IUCN Red List of Threatened Species? Define those categories and assign each species of lemur present in Alan'ny Varika Reserve to one of those categories.
4. Why are lemurs important and why should we care for their conservation?
5. Which of the two forest restoration options has more disadvantages or poses more risks for the future of the reserve?
6. What are the major uncertainties that should be taken into consideration when choosing one or the other option?

Supplement I – Madagascar and Alan'ny Varika Reserve

The island of Madagascar, located off the eastern coast of Africa, is one of the most biodiverse places on Earth (Ganzhorn et al., 2001). Most of the plant and animal species found in Madagascar are found nowhere else. These species, known as endemics, make Madagascar unique. Astonishingly, 100% of the native Malagasy amphibian and terrestrial mammal species, 92% of reptiles, 44% of birds, 74% of butterflies, and more than 90% of plants are endemic (Vences et al., 2009).

Unfortunately, Madagascar's distinctive biodiversity is highly threatened. Madagascar is considered one of 25 world biodiversity hotspots. Hotspots are areas harboring exceptional concentrations of endemic species that are experiencing exceptional habitat loss (Myers et al., 2000). In fact, due to its unparalleled levels of endemicity and the accelerated rates of forest loss, Madagascar has been called the hottest hotspot on Earth (Ganzhorn et al., 2001). Conservation of its threatened endemics, such as lemurs, is a global priority for conservation (Schwitzer et al., 2013). Every year, vast areas of forest disappear, mostly due to illegal logging, charcoal production, slash-and-burn agriculture, and mining (Andrés-Domenech et al., 2014). Over the last 60 years, Madagascar has lost 44% of its natural forest cover (Vieilledent et al., 2018).

This rapid forest loss has pushed many reptiles, birds, and mammals to the brink of extinction, including Madagascar's signature species, the lemurs (Schwitzer et al., 2014). Lemurs are primates, a group that includes monkeys, apes, and humans. Besides humans, lemurs are the only primates inhabiting Madagascar. Lemurs are mostly arboreal. They spend most of their day consuming leaves, flowers, and fruits. Therefore, abundant plant resources are key for their survival. A few lemur species can supplement their diet by eating small invertebrates (Jolly et al., 2006; Gould et al., 2009). Sadly, out of the 111 extant species of lemurs, 93% experience some level of threat according to the IUCN (Schwitzer et al., 2013).

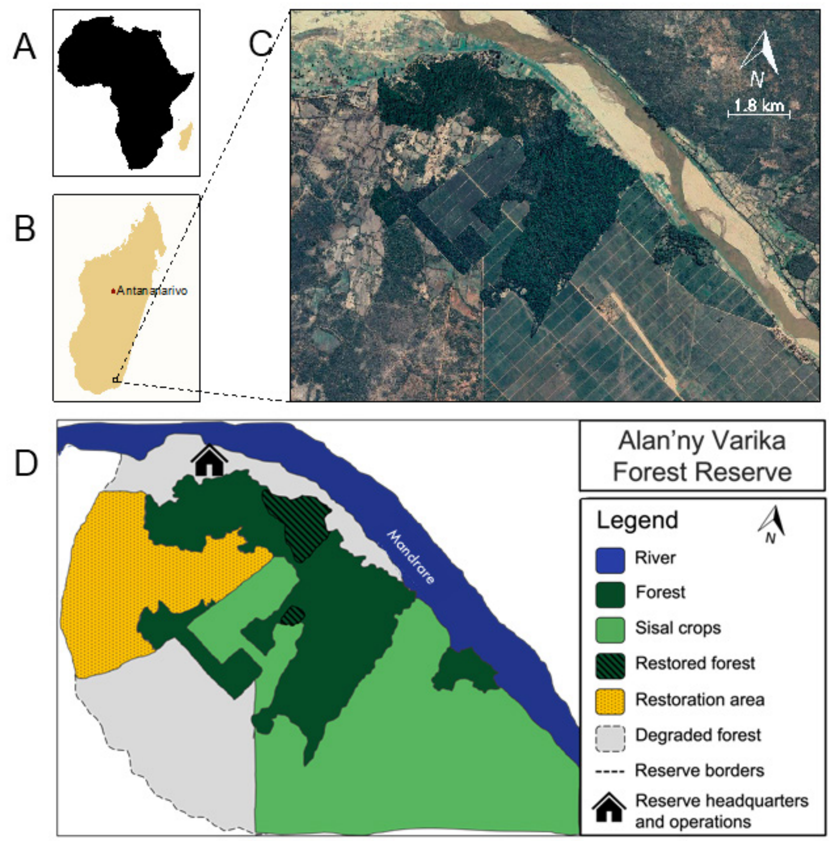

Figure 1. Alan'ny Varika Reserve in Madagascar. *(A)* Madagascar, located to the east of continental Africa and highlighted in yellow. *(B)* Location of Alan'ny Varika Reserve in southeast Madagascar. *(C)* Aerial photograph of Alan'ny Varika Reserve and surrounding area. *(D)* Main areas in the reserve: the well conserved forest is represented in dark green; the diagonal black lines over the dark green show the active restoration sites in the reserve; the yellow dotted area is the pasture where the future forest restoration is projected; and the gray area is degraded forest, currently covered with grasses and a few sparse trees.

Fortunately, there are several areas in Madagascar that are contributing to the conservation of lemurs. One of these areas is the Alan'ny Varika Private Reserve located in southern Madagascar, one of the driest areas in this island nation (Figure1). Alan'ny Varika means "lemur forest" in the Malagasy language. Six species of lemurs live in Alan'ny Varika Reserve's 1000 ha of native tropical dry forest. These forests are some of the last forest fragments remaining in southern Madagascar and so are crucial for conservation.

Over the last two decades, Alan'ny Varika Reserve's forests have been losing forest cover. There are many open spaces (gaps) where native plants have not been able to regenerate naturally. With a growing number of gaps, the reserve's forests have fewer trees, and offer less food resources for lemurs. Severe droughts seem to have contributed to a high tree mortality, especially of the largest and most dominant tree species in the forest like the tamarind *(Tamarindus indica)* and koteky *(Neotina isoneura)*.

Another cause of native forest decline may be the spread of non-native plant species. A non-native (introduced) vine, *Cissus quadrangularis*, has invaded Alan'ny Varika Reserve. This plant has thick, fleshy stems adapted to water storage, which makes it thrive during long dry periods. During the rainy season, it grows rapidly, covering trees and shrubs, impeding their growth and regeneration (Figure 2). To remove Cissus from the forest, vines must be cut and pulled from the trees. The native trees sometimes are unintentionally cut with machetes used to remove Cissus, or severely damaged when the vines are brusquely pulled from the tree. This is a destructive process, especially for young trees, which are not as sturdy. Where vine clearing has created more open areas in the reserve, these gaps are not being colonized by native trees. The open areas are usually dry and exposed to direct sunlight, less suited for native trees, especially those that typically establish under mature canopy. Therefore, the entire forest ecosystem, and the lemurs that depend on it, could be in peril.

Figure 2. Cissus quadrangularis. (A) Shoots and fruits. *(B)* Vine climbing up an *Alluaudia procera* tree. *(C) & (D)* Vine clearing from the forest. *Photos:* Ariadna Mondragon-Botero.

To ensure the long-term viability of the forest and provide enough food resources to maintain lemur populations, active forest restoration efforts are being undertaken in the Alan'ny Varika Reserve. Forest restoration has been ongoing in the reserve since 2016 (Figure 3). Currently, there are two forest restoration sites in the reserve. More than 3000 seedlings from native and non-native species have been planted. Forest restoration in the reserve relies on plants grown in the reserve's nursery; there are no commercial or government sources for dry forest trees in the south of Madagascar.

Figure 3. Restoration plots at Alan'ny Varika Reserve. *Photos:* Ariadna Mondragon-Botero.

The planted seedlings include *Tamarindus indica, Neotina isoneura, Grewia androyensis, Cordia caffra, Pithecellobium dulce, Celtis madagascariensis, Rinorea greveana, Strychnos madagascariensis,* and *Tricalysia dauphiniensis*. The seedlings are maintained in the nursery for three to six months before planting. Once planted, they are watered once a week during the first two years to ensure their establishment. After that period, watering is less frequent to allow the seedlings to adapt to the drier conditions of the forest. Once a year, visiting scientists and local staff from the reserve measure the plant's height and stem diameter. Seedling mortality is recorded as well. Because of this meticulous monitoring of the seedlings, reserve managers have been able to quantify that native seedlings have a 60 percent mortality rate in the nursery, whereas non-native seedlings have a 35 percent mortality rate. Likewise, once seedlings are planted in the field, native species have a 20% mortality rate during the first two years, whereas non-native species have a 15% mortality rate.

Supplement II – Lemurs

Lemurs are arboreal primates native to the island of Madagascar. Some scientists say that lemurs colonized the island, rafting on drifting vegetation from continental Africa, around 40–50 million years ago (Kappeler, 2001). More recently, researchers have found evidence suggesting that lemur ancestors dispersed from continental Africa to Madagascar twice, around 20 million years ago. Although lemur origins are still contested by researchers, they are one of the earliest diverging primate groups (Gunnell et al., 2018). Upon their arrival to Madagascar, lemur ancestors evolved in isolation, giving rise to an exceptional diversity in the island.

Primates can be divided into two groups: simians and prosimians. Monkeys, apes, and humans are simians. Lemurs are prosimians. Prosimians differ from other primates by a strong sense of smell that allows them to find food, detect enemies, and find possible mates. To enhance their sense of smell, lemurs have a humid surface in their nostrils called a rhinarium, very much like dogs and cats. Prosimians also have tooth combs or projections on their lower front teeth, used for cleaning their own fur or that of others in their group (Masters et al., 2013).

There are 111 known species of lemurs that vary in habitat preferences, behavior, size, and diet. Lemurs are widespread across Madagascar, found in nearly all of the island's ecosystems (Schwitzer et al., 2014). The largest lemur is the indri *(Indri indri)*, which can measure up to 27 cm and weigh 9.5 kg. It lives in the rainforest and is well known for its loud whale-like vocalizations that can be heard 2 km away (Zanoli et al., 2020). The smallest lemur is the pygmy mouse lemur *(Microcebus myoxinus)* with a total length of 11 cm and weighing only 30 grams, which also makes it the smallest primate in the world (Schmid et al., 2000) (Figure 4).

Figure 4. Madagascar's largest lemur, the Indri, is shown in the left pane. *Photo:* Christophe Germain, CC BY-SA 4.0. The world's smallest primate, the mouse lemur, is shown in the right. *Photo:* Bikeadventure, PD.

Most lemurs are herbivores and feed on leaves, fruit, flowers, tree bark, and sap (Simmen et al., 2003). Their diets rely on a variety of plants, but some lemurs can be specialists, feeding from just one species of plant like the greater bamboo lemur *(Prolemur simus)* that gets almost all its food from a single species of native woody bamboo *(Cathariostachys madagascariensis)* (Ballhorn et al., 2016). Some species, like the ring-tailed lemurs *(Lemur catta)* are omnivorous, and besides plants, they supplement their diets by eating small insects, and even chameleons.

Some lemur species are diurnal, meaning that they are mostly active during the day. Others are nocturnal, mostly active during the night. These species are distinguishable because they often have big round eyes. Also, some species are cathemeral, being active during both day and night (Donati et al., 2007).

Lemurs' major predator is the fossa *(Cryptoprocta ferox)*, Madagascar's largest mammalian carnivore. Fossas are a cat-like species that are also endemic to Madagascar and in decline (Hawkins & Racey, 2008). But lemurs, especially young ones, are also prey for snakes and large birds. However, lemurs' main threat are not predators. Lemurs are facing diminishing populations because of habitat loss, mostly due to deforestation for mining, charcoal production, agriculture, and illegal poaching for pet trade (Schwitzer et al., 2014, 2013).

Lemurs are crucial for Madagascar's forests since they are the main seed dispersers on the island. In most tropical forests birds are the most abundant group of frugivores, and thus have a predominant role in seed dispersal. This is not the case in Madagascar, where only five bird species have been reported as mainly frugivorous (excluding granivores) (Albert-Daviaud et al., 2018). Due to their disproportionate importance as seed dispersers, their absence from the forest could be catastrophic. Without lemurs, many plant species in Madagascar could disappear (Wright et al., 2011).

Lemurs are not only important for the forests in Madagascar; they are considered sacred by the Malagasy people. Hunting or eating lemurs is considered taboo or *fady* (in Malagasy language). The indri *(Indri indri)* is protected by the Sakalava people as is the black lemur *(Eulemur macaco)* by the Betsimisaraka in the east coast of Madagascar (Harpet et al., 2000). Lemurs are thought to be forest guardians and are also part of Malagasy creation stories. For example, the Milne-Edwards sifaka *(Propithecus edwardsi)* are considered ancestors in animal form (Jones et al., 2008).

Lemurs are also crucial for the economy of Madagascar. These charismatic animals attract millions of tourists every year that fly to the island to see them in their natural habitats. Thanks to lemurs, ecotourism is one of the country's major income sources, and entire families rely on it for their subsistence (Schwitzer et al., 2013).

The Lemurs of Alan'ny Varika Reserve

In Madagascar, there are several national parks, conservation centers, and natural reserves established to protect lemurs from extinction. One of those places is Alan'ny Varika Reserve, located in the south of the island. Alan'ny Varika Reserve is home to five species of lemurs, two diurnal and three nocturnal. In Alan'ny Varika Reserve, lemur species live in dry gallery and spiny forests, where water is often limiting. The lemurs of the reserve are adapted to an irregular food and water supply due to highly variable rainfall and long dry seasons.

Grey Mouse Lemur *(Microcebus murinus)*

This lemur (Figure 5) is one of the smallest in Madagascar. They can attain a body weight of 60 g in adulthood (just a little more than a tennis ball). This species is mostly arboreal. They sleep during the day in groups. Usually, females sleep in large groups of up to 15 individuals, separated from males. They are active during the night, eating leaves, flowers, and nectar, and also chasing small chameleons or tree frogs. They are common in the dense forest of the west and the dry forest in the south of Madagascar (Ganzhorn & Schmid, 1998; Steffens & Lehman, 2016).

Figure 5. Grey mouse lemur *(Microcebus murinus)*. *Credit:* Gabriella Skollar, CC BY-SA 3.0.

Gray-Red Lemur *(Microcebus griseorufus)*

This is a large species of mouse lemurs that inhabits the spiny forests of southern Madagascar (Figure 6). Their diet consists mostly of leaves and tree sap, but they can also eat insects and small invertebrates. During the dry season, when food resources are scarce, they enter a state of torpor. During this time, their metabolic activity is greatly reduced, and they remain inside tree trunks. This behavior allows them to survive periods of reduced food availability. Although these lemurs are abundant, their populations are decreasing due to habitat loss (Rasoazanabary & Godfrey, 2016).

Figure 6. Gray-red lemur *(Microcebus griseorufus). Photo:* Allain Hopkins, CC BY-NC-ND 2.0.

Figure 7. White footed sportive lemur *(Lepilemur leucopus). Photo:* David Cook, CC BY-NC 2.0.

White Footed Sportive Lemur *(Lepilemur leucopus)*

These somewhat larger lemurs (Figure 7) are also active at night, eating mature leaves. During the day, they sleep inside tree trunks or remain hidden in dense vegetation mats. They are very inactive in the daytime, to save energy for eating and escaping predators. They are only found in the dry forests in the south of Madagascar. This species is considered endangered mostly due to habitat loss (Dröscher et al., 2016; Dröscher & Kappeler, 2014).

Ringtailed Lemur *(Lemur catta)*

Ring-tailed lemurs are probably Madagascar's most recognized species. Its long tail displaying black and white fur stripes is remarkable. For male lemurs, the tail is vital. They rub it against odor glands in their bodies, and then they swing it in the air to catapult scented hormones to other males and deter them from their territories. Ring-tailed lemurs live in female-dominated groups that range from 3 to 30 individuals. In the mornings, it is common to observe them sitting upright on the ground, very still, with their arms spread wide, as if meditating. They do this to sunbathe and warm up their bodies to start the day. They spend most of the day foraging in a specific territory, well delimited by scent marks produced by rubbing their bodies against the trees (Masters et al., 2013). Ring-tailed lemur populations are endangered, and their populations exhibit a decreasing trend (LaFleur et al., 2016).

Figure 8. Ringtailed lemurs *(Lemur catta). Photo:* Licensed, ©Eric Gevaert | Dreamstime.com, ID 20124866.

Verreaux's Sifaka *(Propithecus verreauxi)*

This species is best known as "dancing lemurs." Sifakas are mostly arboreal, but when they walk on the ground, they just use their hind legs. They move so gracefully, leaping and balancing their bodies from one side to another, that they look as if they were dancing. Sifakas got their name because when they want to alert others of the presence of a predator, they emit an alarm vocalization that sounds like "sifak sifak." Sifakas also live in female-dominated groups of up to six individuals. Females have one baby per year that they carry in front or on their backs until they are almost one year old. It is a true delight to see the mother jumping from tree to tree with their baby tightly grabbing the mother's fur. They rely mostly on leaves, flowers, bark, and sap for their diet, which they eat during the early morning and late afternoon. During the warmest hours of the day, sifakas usually take long naps (Richard, 1976). This species was declared critically endangered in 2018 (Louis et al., 2020).

Figure 9. Verreaux's sifaka *(Propithecus verreauxi)*.
Photo: Ariadna Mondragon-Botero.

Additional Resources

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Tropical dry forest (English version). [Video]. Produced by Royal Botanic Garden Edinburgh, 2015. Running time: 3:37 min. <https://youtu.be/m6XN65eMtg4>

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