

RESEARCH ARTICLE

Conservation Education in Madagascar: Three Case Studies in the Biologically Diverse Island-Continent

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Few Malagasy children and adults are aware of the rare and unique fauna and flora indigenous to their island-continent, including flagship lemur species. Even the Malagasy ancestral proverbs never mentioned lemurs, but these same proverbs talked about the now extinct hippopotamus. Madagascar's geography, history, and economic constraints contribute to severe biodiversity loss. Deforestation on Madagascar is reported to be over 100,000 ha/year, with only 10–15% of the island retaining natural forest [Green & Sussman, 1990]. Educating children, teacher-training, and community projects about environmental and conservation efforts to protect the remaining natural habitats of endangered lemur species provide a basis for long-term changes in attitudes and practices. Case studies of three conservation education projects located in different geographical regions of Madagascar, *Centre ValBio*, *Madagascar Wildlife Conservation Alaotra Comic Book Project*, and *The Ako Book Project*, are presented together with their ongoing stages of development, assessment, and outcomes. We argue that while nongovernmental organizational efforts are and will be very important, the Ministry of Education urgently needs to incorporate biodiversity education in the curriculum at all levels, from primary school to university. *Am. J. Primatol.* 72:391–406, 2010. © 2009 Wiley-Liss, Inc.

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INTRODUCTION

Conservation Education in Madagascar

Few Malagasy have ever seen a lemur in the wild; 90% of the population of Madagascar do not live near a forest. The few that do belong to two minorities: people living on the edge of the dwindling forests, and highly educated and dedicated conservationists. This is in spite of the fact that for westerners, Madagascar's fame is its endemic flora and fauna, including what may be more than 100 species of lemurs, many of them newly described [Mittermeier et al., 2008]. Malagasy culture includes many traditional proverbs inspired by domestic animals (cows or chickens) observed in daily life [MINESEB-UNICEF-SNIC, 1985–1988; MINESEB-CRESED-UERP, 1998–1999; MINESEB-CRESED-UERP, 1998–1999; Programmes Scolaires en Primaire & Au Lycee] and even some about the now extinct hippopotamus, but few about living endemic species, which reflects a general lack of knowledge or even a fear or dislike of these species [Ratsimbazafy, 2003]. Nevertheless, during the last two decades, conservation has become a government policy and nongovernmental organizations (NGOs) have contributed

approximately \$38 million in 2008–2009, to ensure preservation of endemic species in Madagascar [Rabenandrasana, 2005; Ratsimbazafy, 2003; Madagascar Environment Program Phase II (PEII)].

Because most Malagasy children are unfamiliar with Madagascar's unique species, it follows that as adults few will have an interest in conserving endangered biodiversity [Ratsimbazafy, 2003]. Typically, children are not taught about native wildlife or the science of conservation in schools. Instead, they

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are more familiar with giraffes, lions, tigers, and polar bears, animals that do not exist in Madagascar [Ratsimbazafy, 2003]. In fact, a television-watching child in the west knows more about lemurs than most Malagasy children do [Ratsimbazafy, 2003; Jolly, personal observation]. There are three general causes for this, all of them deep-seated. First, is the geography and human population distribution on the island-continent. Second, there is a long history of neglect of biodiversity within the main educational system. Third, Madagascar was the tenth poorest country in the world by the start of the twenty-first century; in fact, the poorest that did not have civil or external wars—so there were few funds for conservation education [World Development Report, 2000/2001]. The economic constraints both reflect and exacerbate unequal power between peasants, elites, and foreign donors, which has impacted in many ways on the school system.

Of these three aspects, geography is fundamental. In a land area of 587,000 km² (Fig. 1), native forest may still cover as little as 15% of Madagascar, and within these forests some 90% of species are endemic. The remaining forests form a broken circle, inland from the periphery: what Bernhard Meier dubbed “The necklace of pearls” [Jolly, 1990]. The center of power, however, is the capital, Antananarivo, on the central plateau, almost as far as possible from any forest. People of the plateau are of predominantly Indonesian descent, with a heritage of Indonesian-style intensive paddy-rice farming and the “involuting,” hierarchical, social system that



Fig. 1. Map of Madagascar's terrains, areas of forest loss, and locations of the three case studies presented in this article. Map after EU Joint Research Centre [Achard et al., 2002].

tends to arise in any paddy-rice society [Geertz, 1963]. People on the coast, of more African descent, tend to have freer social rules of marriage and divorce, and a tradition of *tavy* (swidden, slash and burn) agriculture, which requires access to large areas of forest fallow land. Besides the physical distance and the differences of ethnicity, culture, and lifestyle, the modern road system (or lack of it) means that for the nonflying classes travel between different parts of the island is long, painful, and only undertaken when necessary. In short, the forest with its plants and animals is a resource for those who live nearby and a distant frontier for the more influential people who do not.

The second problem is the history of the school system. Schools worldwide are caught between the hope of education for all and the constant pressure to concentrate on those who can rise to the next levels of schooling and salary. In Madagascar, this tension has often translated into the language question: should children learn to read in Malagasy, or should they learn French, the passport to a possible white-collar job? Table I presents a brief resumé of past changes in the public education policy in Madagascar. Within a system characterized by changes in governments, goals, and policies, Madagascar's biodiversity was not included as part of the core curriculum in public education [Ratsimbazafy, 2003]. There was, however, a good deal of environmental education about soil, water, and especially the evils of setting bushfires, though this was not directly related to how this knowledge would benefit local lifestyles and conservation, and actual land use.

The final constraint is the economy. In 2007, 85% of the population of 19 million people were under the poverty line at \$2/day, with a literacy rate of 63% [World Bank, 2007]. The Human Development Index, which combines measures of income, literacy, and life expectancy, put Madagascar at 143 among 177 countries in 2007–2008 (30 countries of mainland Africa rank even lower) [UNDP, 2008]. In absolute terms, Madagascar's per capita income in 2007 was \$320, which is 143 times less than that of the United States, or calculated in terms of local purchasing power, per capita income is 50 times less than in the United States [World Bank, 2008a]. Sub-Saharan Africa, including Madagascar, has had a 25-year Great Depression—much worse in terms of both income declines and duration than anything that the West went through in the 1930s (Fig. 2). The slump was only partially owing to a policy of socialism and ensuing corruption combined with population growth [World Bank, 2007, 2008a]. It was also the result of externally imposed structural adjustment, which led in most African countries to cuts in health and education, as well as to plummeting commodity prices and spiraling debt repayments. Primary teachers' salaries as of 2004 were 4.1 times per capita GDP, compared with a Sub-Saharan

TABLE I. A Brief History of Educational Policy in Madagascar

Period	Dates	Events	Goals	Constraints	Biodiversity education
Early settlement	~100~1600	Extinction of megafauna, agriculture rather than hunting-gathering			
Early precolonial	~1600	European contact, rise of kingdoms in all parts of the island			Scientists, e.g., Commerson: "Madagascar the naturalists promised land"
Merina rule	1798-1897	Merina kingdom conquers most of Madagascar	Missionaries in Imerina and Betsileo fostered a literate Christian elite	Martyrdom under Queen Ranavalona III	Scientists, e.g., Grandidier's Encyclopedia; Merina laws against non-Merina cutting forests
Colonial	1897-early phase	French administration	Basic literacy and numeracy for farmers and artisans	School enrollments dropped to 1/5th precolonial numbers	National wilderness reserves founded from 1927, off-limits to all but research scientists
Colonial	To 1960-later phase	French administration	Equal opportunity for all through the uniform French curriculum: goal to rise to secondary school and beyond as in France	Schools wholly in French from year three on: huge advantage to those with Francophone families	Madagascar's biodiversity mentioned in biology of French colonies for the very few who reached lycée level. Technical training for forestry personnel. Campaigns against bush fires and forest clearance, but for soil rather than biodiversity
First Republic	1960-1972	French influence	Equality with France for elite: lycée and university degrees given by France	As above	As above
Transition	1972-1975	Transition era	Equal opportunity for Madagascar; primary school in official Malagasy, lycée and University in French	Coastal children did not know official Malagasy while ambitious parents put children in private francophone schools	No incentive to add biodiversity teaching to restructured curriculum
Second Republic	1975-1985	President Ratsiraka's Malagasy Socialism		No effective professional support; teachers' salaries often unpaid	B. Vaohita of WWF wrote series of primary school reading books on nature, <i>Ny Voary</i> : poems and stories, with a few facts about Madagascar's own biodiversity
	1985-1990	IMF/World Bank Structural Adjustment	Spreading access while cutting costs: World Bank-sponsored recruitment of minimally trained teachers with two years of high school	Economic stagnation and corruption: teachers need second jobs or farming to live, salaries often unpaid	WWF distributed <i>Ny Voary</i> and a comic book, <i>Vintsy</i> , nationwide, with lycée level <i>Vintsy</i> nature clubs, but not incorporated into curriculum or teacher training. Widespread conservation action by foreign aid and NGOs
	1991-1995	Forces Vives government	Increase educational effectiveness by return of French as dual language for primary school along with Malagasy		

TABLE I. Continued

Period	Dates	Events	Goals	Constraints	Biodiversity education
	1995-2002	President Ratsiraka reelected	Same	Same	Same
	2002-2010	President Ravalomanana elected	Plans for restructured school system, economic upturn	Legacy of poor teacher training and pay	Biodiversity taught piecemeal by Madagascar and foreign NGO's in their spheres of influence, not nationally
	2009	Transition government	Plans on hold	Donor sanctions on government aid	Same

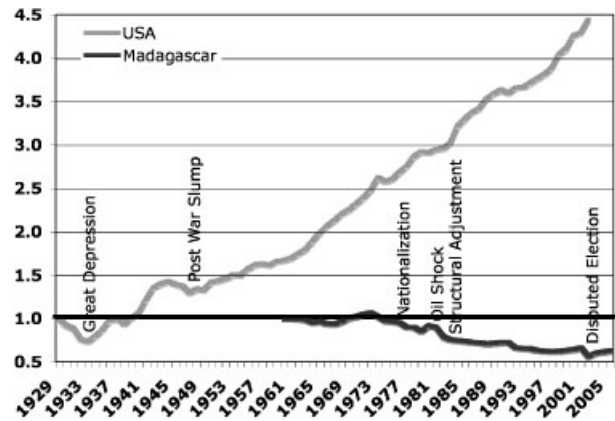


Fig. 2. Cumulative percent growth in per capita income, constant dollars, starting at year 1929 for the United States and 1960, the year of Independence, for Madagascar. In the US's Great Depression, income sank to a low of 3/4th previous income and ended in five years. Madagascar sank to almost half its per capita income in a depression lasting 25 years. In 2007, Madagascar's absolute per capita income was 1/143rd of the United States, or in local purchasing power, 1/50th of the United States.

average of 4.6 times per capita GDP [World Bank, 2008b]. However, the comparisons with GDP mask the drop in both over the past decades. Malagasy teachers' salaries halved in real terms between 1970 and 1990, with no rebound by 1997 [Lambert, 2004]. An African Development Bank report of 1998 identified low salaries as the most harmful factor for the education system in general in Africa [Lambert, 2004]. The consequence is high teacher absenteeism, of the order of 20% or more, and that the majority of teachers hold second jobs [Lambert, 2004]. Teachers do the best they can with rote learning, extra fee-paying lessons after school, and a pupil-teacher ratio in 2004 of approximately 53, although this is a low figure obtained by dividing the total primary school population by the total number of primary school staff [www.childinfo.org/files/ESAR_Madagascar.pdf: UNESCO Institute for Statistics].

In this context, education about biodiversity has largely been left to the foreign-funded conservation NGOs. The next section will provide three case studies of such initiatives and analysis: (1) Centre ValBio near Ranomafana National Park, (2) teaching about *Haplolemur* (the bamboo lemur) at Lake Alaotra, which is Madagascar's chief rice-producing area, and (3) the Ako Project of books, posters, and educational support. The map of Madagascar, Figure 1, indicates the location and terrain of the three case studies described in this article. For each case study, testing procedures of human participants complied fully with the ethics required within the country of Madagascar. Additionally, all research reported in this manuscript adheres to the American Society of Primatologists (ASP) Principles for the Ethical Treatment of Non-Human Primates.

With the election of President Ravalomanana in 2002, the Malagasy government began a set of programs targeted to improve education. School fees were eliminated for public primary schools, and a million additional children enrolled. The net enrollment ratio in primary schools rose from 67% in 2001–2002 to 98% in 2004–2005 [World Bank, 2008b]. Many new schools were built, but changes on this scale present huge challenges. In 2008, the Ministry of Education, using an \$85 M multi-donor “Catalytic Fund,” embarked upon a 5-year plan to massively restructure the teaching curriculum, including an ambitious plan for teaching support. Conservation became a major plank of the Madagascar Action Plan (MAP), including building conservation into the new curriculum; as of early 2009, Table II outlines proposed educational reforms. However, the recent change of Madagascar’s government in March 2009 has led to violence and the cancelling of most foreign aid, as well as to national economic free-fall. It is unclear if any of the proposed reforms will be carried out. More than ever, the efforts of NGOs will continue to be crucial to conservation education.

THREE CASE STUDIES

Centre ValBio Near Ranomafana National Park

Methods and sites

Ranomafana National Park (RNP), a 41,601 ha protected area in Madagascar’s south-eastern rainforest, was established in 1991, becoming part of a World Heritage Site in 2007, and is the third most frequently visited national park in Madagascar [Unpublished Ecotourism Report, Ranomafana National Park, 2008]. However, forest degradation and natural resource exploitation still occur around the park, especially as a result of slash and burn agricultural practices (tavy), which gradually erodes the soil in areas around the park’s periphery [Patterson et al., 1995]. Degradation causes loss of habitat for much of the endemic fauna and flora. This includes several vulnerable, endangered, or critically endangered lemurs, such as the black and white ruffed lemurs (*Varecia variegata*, CR), greater bamboo lemurs (*Prolemur simus*, CR), golden bamboo lemurs (*H. aureus*, EN), and Milne–Edward’s sifakas (*Propithecus edwardsi*, EN), as well as red-bellied lemurs (*Eulemur rubriventer*, VU), lesser bamboo lemurs (*H. griseus*, VU) and aye-ayes (*Daubentonia madagascariensis*, NT). These lemurs are also important magnets for tourism, a major source of income for the region.

The main anthropogenic pressures at Ranomafana National Park are related to poverty, lack of educational opportunities, population growth, and adherence to traditional practices that include

acquiring more land by tavy without sustainable alternatives. How to reconcile biodiversity conservation with poverty reduction and rural development is a major ongoing debate [Korhonen, 2006; Rowe, 2008].

The efforts to mitigate and end the negative impacts of natural resource and forest degradation are hampered by limited communication (rural isolation, lack of education, lack of outreach tools, illiteracy). Residents of the peripheral zone lack access to information about (a) the importance of conserving the rainforest and its biodiversity, (b) the essential ecosystem service the forest supplies provide, and (c) the dependence of human livelihoods on a healthy ecosystem. Centre ValBio’s outreach education programs are designed to combat these systematic deficiencies.

Centre ValBio—the International Research and Training Centre for the Valorization of Biodiversity—is situated on the edge of Ranomafana National Park. Its mission is to increase the perceived importance and value of biodiversity through research, training/capacity development, and awareness/education. The conservation education outreach program is based at Centre ValBio, at the Kianja Maitso Environmental Education Centre in Ranomafana village, and in target schools and villages in RNP’s peripheral zone. Conservation education is delivered through a variety of programs, from classes, demonstrations, folklore, and paintings.

In order to achieve its mission, Centre ValBio has adopted four main strategies: (1) *Select and prioritize target audiences*: Among the 25,000 inhabitants living around RNP, a total of 3,729 schoolchildren in 15 schools, 688 members of 15 Conservation Clubs, and 868 households from 22 villages have been targeted by the conservation education outreach program to act as models for other communities. (2) *Select and train relay groups*: 185 individuals, including 30 Conservation Club Leaders (CCL), 35 Local Technical Agents (ATL), 38 Voluntary Health Workers (AVS), and 82 members of the Environmental Education School Committees (Com EE) were selected and trained to act as relay groups partnering with Centre ValBio in implementing its education program. (3) *Develop a participative approach*: Centre ValBio plans all its interventions together with its partners and target audiences. Only those who show interest and make efforts receive rewards, which are always relevant—for example, watering cans and seeds for conservation clubs and books for school children. (4) *Develop communication tools*: Centre ValBio developed effective communication tools to facilitate transmission of messages and alternatives to the various target audiences. Use of games, slogans, banners, and audio-visual tools help reach illiterate audiences [Jacobson et al., 2006].

TABLE II. Some Aspects of the 2008–2015 Proposed Educational Reform

Level	Change	Goals	Constraints	Biodiversity
Primary	Increase from 5 to 7 years	Most children will finish 7 years in primary schools near home, then be old enough to move an average 18 km to nearest collège	Average school tenure now 4.4 years including 30% repetition of early years	Included? Included?
	Maternal tongue instruction	All children start school in their own dialect, so they can learn to read and do sums	Children cannot progress further without French and official Malagasy: parents choose private francophone schools	
	French, English, and official Malagasy as second languages	Malagasy to become trilingual like Mauritians; English as necessary in the internet age	Many primary teachers barely speak French, almost none have any English	
	Curriculum reform Interactive teaching	Practical and academic life basics Encourage thinking rather than squashing it	Teacher retraining, new books Teacher retraining	
Secondary	Two year “collège” then either 3 year “lycée” or technical training	Educated elite and technicians	Low level of current technical training and lycées	Included? Included?
	Official Malagasy instruction French, English compulsory Curriculum reform	Increased comprehension of subject matter English for Internet and international trade	Parents choose francophone schools Lack of English teachers Teacher retraining, lack of new books Computers and internet	
University	Change from French system to US/UK Bachelors, Masters, PhD	Shorter and less cumbersome education, adapted to modern world	Faculty all over the world hate changes	

The components of Centre ValBio's environmental education are reforestation, biodiversity conservation education, and health education. Centre ValBio's "outdoor classroom" provides rainforest class sessions for Ranomafana school groups, for schools from nearby cities, and for tourists. Kianja Maitso (Green Space), an environmental education facility located in the nearby Ranomafana village and jointly managed with Madagascar National Parks, has a classroom and library. In addition, demonstrations of alternatives to forest destruction are presented (e.g., improved agricultural techniques, bee keeping, and fish farming). Based at Kianja Maitso, Centre ValBio has tree nurseries, stored seedlings, and staff who demonstrate these teaching tools. The reforestation program (thousands of seedlings planted in and around target villages and schools) restores degraded land and buffers RNP. Kianja Maitso's waste management, recycling, and biodegradable rubbish programs educate about using resources wisely, and provide compost and other reuseable materials. Model botanical gardens of plants used by lemurs, bees and silk worms, and medicinal plants demonstrate interdependence between plants and animals within the natural ecosystems, and support the themes of the "bees for trees" project. Small ponds demonstrate aquaculture techniques.

In collaboration with Madagascar National Parks, Centre ValBio developed an education display, *KajiAla* (Forest Conservation), to help local people understand the value of the rainforest and the need to protect it while also improving their standard of living. Kianja Maitso is also a place where local residents can appreciate each other's conservation efforts, as models for villages in the peripheral zones, and to offer training in alternative agricultural methods to slash-and-burn (tavy).

In the villages, where many young people may not attend school, Centre ValBio leads a 9-month curriculum-training program for Conservation Club members (number of sessions: 60; club members: 575; age range: 10–58; number of clubs: 15). Biodiversity topic-based classes include information about the lemurs, birds, and medicinal plants of RNP. Club members are encouraged to become advocates for nature and biodiversity, and to demonstrate good attitudes and practices through their daily life. Village conservation clubs choose a biodiversity flagship species name (e.g., *Club Taitso* (blue coua) and *Club Aureus* (golden bamboo lemur)). The Conservation Club program also offers theme-based training in basic methods used to improve agriculture practices and harvests, in order to improve productivity as an alternative to forest destruction via slash-and-burn. Practical classes include: vegetable gardening, cross-season culture, composting, community tree nurseries, fruit tree production, and handicraft production.

The program, *Children and Trees Growing Together*, involves teachers, parents, and school children in improving the school environment, appreciating the value of forests, and complexity of a multilevel interactive ecosystem. Children are taught to care for nursery trees for planting in school reforestation programs. Tasks include preparing pots to grow seeds, watering seeds on a regular basis, monitoring growth (collecting data on sprouted/unsprouted seeds, leaf numbers, and tree height), and replacing failing seedlings.

Centre ValBio regularly organizes a competition amongst the nine schools to evaluate education and reforestation activities using questionnaires for each level: Level 1 (Grade 1–Grade 2); Level 2 (Grade 3, Grade 4, Grade 5); and Level 3 (*Club de Conservation*). The questions include themes, such as: What do we mean by "environment"? Why should we protect the environment? What do we mean by protected areas? and Does Ranomafana have protected areas? Competitions promote valuing cultural and local knowledge; questionnaires also ask for proverbs, poems, recitations, and histories, and children are asked to draw a picture depicting the statement: Imagine and describe your environment in 15 years time. The aim is to encourage children to imagine (and work toward) a future that includes a healthier environment.

RESULTS

Centre ValBio Environmental Education in Schools and Villages

In 2007 and 2008, 571 tourists, 1,165 pupils from 28 schools, and 246 visitors from 6 NGOs visited Centre ValBio. Additionally, Centre ValBio's environmental education and reforestation program is presently in 15 of 54 schools, and a health education and young naturalist Conservation Club program in 22 of 123 villages surrounding the National Park. Beginning in 2006, Centre ValBio provides rainforest classes to schoolchildren in 15 schools following a 9-month curriculum, with focus on RNP biodiversity and classes in reforestation techniques (e.g., collecting seeds and planting seedlings) (Table III). In the program, "Children and Trees Growing Together," 5000+ seedlings have been planted. All 15 schools in the program presently have created their own tree nurseries, arboretums of native trees, and botanical gardens.

To date, 574 of 688 Centre ValBio conservation club members have completed the 9-month training on biodiversity, sustainable alternatives, and communication techniques. Ten of 15 clubs provided lists of local plants and animals that they plan to learn about and protect. Each club is encouraged to create "living laboratories" by which to initiate research at their own level of expertise through collecting census data on plants and animals and ecological

TABLE III. Program of Rainforest and Reforestation Classes in Schools Around Ranomafana National Park

Year	# RF sessions/ school/month	# RF class pupils ^a	Age range RF classes	# RFS sessions/ school/month	# RFS class pupils ^a	Age range RFS classes	# RF and RFS themes	# schools
2006	45 (2)	750	5–24	162 (2)	1,300	6–24	14/8	9
2007	45 (2)	852	5–24	162 (2)	2,364	6–24	14/8	9
2008	36 (2)	725	5–24	108 (2)	1,230	6–18	6/8	6

RF, rainforest; RFS, reforestation

^aThe number of pupils varies per year. In 2008, the schools were in small rural villages (fewer pupils).

measurements. There has been a large increase in clubs' demand for young native trees as well as fruit trees, with 5 of 15 requesting more than 3,000 plants. Five of 15 clubs have requested assessments of the area that could be managed by club members. Outcomes on the competition questionnaires resulted in 2,150/2,364 pupils participating and 70% of the pupils responding correctly to 80% of the questions. Moreover, since Centre ValBio began classes in rainforest and reforestation in 2005, the impact on school results are: 71 pupils from 9 target schools succeeded in passing the exams (50 CEPE (Certificat d'Etudes Primaires et Élémentaires, entrance to Middle School), 2 BEPC (Brévet d'Etudes du Premier Cycle, entrance to High School), and 19 BAC (Baccalauréat, entrance to University)), whereas in 2006, 151 students passed their exams (131 CEPE, 6 BEPC, and 14 BAC).

Discussion: Centre ValBio

Initial Centre ValBio program results suggest that understanding of the status, role, and value of biodiversity are increased through involvement with the educational programs. The conservation education materials produced for school children and villagers on biodiversity (especially lemurs, birds, and insects) appear to support teachers and communities in understanding rainforest biodiversity and their value, and reach a wider audience through outdoor educational panels and other community programs. Involvement in a conservation club provides opportunities for young people, especially village adolescents, to increase level of knowledge by converting environmental "destroyers" into environmental advocates. Centre ValBio builds ownership by providing "learning by doing" training in project planning and management.

Centre ValBio began with nine target schools and conservation clubs and is now targeting 15 of each. The existing successes act as models with new clubs/villagers/schools added. The ultimate aim is to include approximately 25,000 farmers living in RNP's peripheral zone, who subsist primarily by paddy or slash-and-burn rice cultivation, to be involved in conservation programs through Centre ValBio, Kianja Maitso, or schools and villages, and become directly involved in restoring degraded habitats around the park.

Centre ValBio uses a participative approach to build a climate of confidence on the basis of dialogue. This includes participatory diagnosis and evaluation of results; raising awareness and discussion of environmental problems, impacts and the use of alternatives; using the reaction of target audiences—to make decisions and promote change; and a strong emphasis on sharing knowledge and transferring skills. This supports the International Union for the Conservation of Nature's (IUCN) mission "to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable" (www.iucn.org/about).

Madagascar Wildlife Conservation's Comic Book Project on *Haplemur alaotrensis*

Methods and sites

In understanding how to inform both children and teachers in schools and communities about the importance of conserving species, it is critical to know how much Malagasy children in primary and secondary schools know about lemurs and other endemic species; how much do the teachers in primary and secondary schools know about endemic plants, reptiles, birds, and lemurs; and how much does the general public in Madagascar know about lemurs.

The Alaotran gentle lemur or *Bandro* (*H. alaotrensis*) is one of the most endangered lemurs owing to the rapid disappearance of its habitat, the marshes of Lake Alaotra, by tavy and hunting [Mutschler et al., 2001]. To counter these threats, the Malagasy-based NGO Madagascar Wildlife Conservation (MWC) produced a conservation comic book and distributed it in four selected villages (Andreba, Ambodivoara, Andilana sud, and Anororo) where the largest subpopulations of *Bandro* are left. The four villages in this study are adjacent to 90% of the marsh habitat where the *Bandro* live. Two of the four villages (Ambodivoara and Andreba) are located in the east part of the lake and the other two (Andilana sud and Anororo) in the west. Other rare endemic animals inhabiting the Lake Alaotra marshes are five fish species (e.g., *Rheocles sikorae*, *R. alaotrensis*), ten waterbirds (e.g., *Ardeola idae*, *Tachybaptus pelzelni*), and a newly discovered small

carnivore (*Salanoia nova* sp.). The comic book devised by MWC focuses on the Bandro and on the dominant vegetation in the lake and marsh area (e.g., *Papyrus* and *Phragmites*).

The comic book is divided into eight different thematic episodes that include stories about hunting, lemurs as pets, the importance of an intact marsh habitat, and the consequences of fires. An episode consists of 12–24 pictures written in Malagasy, with a themed conservation message. The main characters in the comic strip are a Bandro called *Malala* (sweet), a kingfisher called *Haja* (respect), and a Meller's duck called *Solofo* (generation) as representatives of the wildlife. The villagers' point of view is represented by two girls and two boys aged between 6 and 11 years, and the story is presented as real-life situations that children may encounter.

The MWC initiated this education project in the Alaotra-Magoro region with the aim of raising the awareness of school children about the significance of the natural environment, so it will filter into the communities. The long-term goals for this project are to: (1) broaden the horizon and knowledge of the school children and future adults of the complexity of the natural and agricultural environment of the Alaotra region; (2) help young people to appreciate their own environment and to encourage them to share what they learn with their respective communities; and (3) become actively responsible for their own living space and resources and to enable them to protect these species.

Four of eight primary school classes (466 children; Experimental) were chosen to receive the comic books and related teacher-training workshops (conducted in November 2006–February 2007). Assessment concluded with a questionnaire to test the children's knowledge. For comparison, four other equivalent classes (Control) not presented with comic books or teacher-training were also given the questionnaire (217 children). The age range of the pupils in the eight-test classes was from 9 to 12 years.

Before the project was initiated in the classrooms, teachers in the four experimental classes were given special training by conservation instructors from Parc Ivoloina (Madagascar Fauna Group), MWC, and Circonscription Scolaire (CISCO, the school authorities). The conservation instructors taught teachers about topics such as biodiversity, fundamental environmental problems, basic ecology, and related subjects. These topics reflected issues raised in the comic books. The teachers were trained to hold discussions about these topics with their pupils. In collaboration with the school district authorities in Ambatondrazaka and Amparafaravola, the MWC provided training to the teachers about the different methods of using the comic books and holding discussions in class. This was followed up by another training session on the use of the evaluation

guide. One of the main points was to train the teachers to explain important concepts using the environmental education pedagogical techniques (as recommended by World Wildlife Fund).

After a test phase of four months, MWC gave pupils a questionnaire with the aim of evaluating the influence of the environmental education program on the children's understanding of the environmental complexities of the lake and marsh system. The results of the questionnaires from both groups, Control and Experimental, were compared to determine an effect of teacher-training and comic book distribution, specifically on retained knowledge and attitude change.

The questionnaire contains 26 multiple-choice questions. Questions include topics such as whether certain plants should be harvested from the forest and why; why certain types of environments are special habitats for specific wildlife (e.g., marshes and forest); why certain animal species should not be hunted; whether it is acceptable to keep animals from the forest as pets or selling them for pets; and the diet of Alaotra Gentle Lemurs. In tabulating results, if no answer or more than one answer was chosen, the entire question was discounted in the analysis.

Results: Madagascar Wildlife Conservation's Alaotra Comic Book Project Evaluation

A critical component in evaluating the projects' efficacy is the comparisons between the Experimental and Control groups. Average scores for each village school in the Experimental and Control groups are summarized in Figure 3. Comparisons of average scores obtained from the questionnaires of pupils who had received the comic books and taken part in classroom discussions with trained teachers (Experimental Group) and those who did not receive

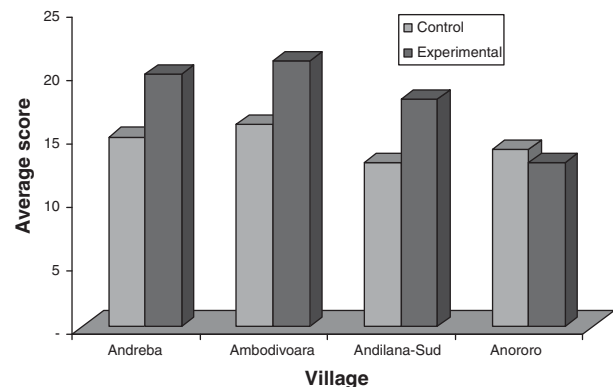


Fig. 3. The bar graph shows the average ages of pupils given the questionnaires in the Alaotra study, and the scores out of 26 possible correct answers for pupils in the Control (pupils not receiving comic books or having in-class discussions with their teachers) and Experimental (pupils receiving the comic books and in-class discussions with their teachers) groups.

these interventions (Control Group) indicate significant differences (Experimental Group vs. Control Group: Andreba (20 vs. 15); Ambodivoara (21 vs. 16); Andilana Sud (18 vs. 13); and Anororo (13 vs. 14)). The results show that the pupils in the Experimental Group had, on average, higher scores than those in the Control Group. An unpaired *t*-test indicates significant differences between these two groups: $F(14, 225) = 14.22, P < 0.001$.

Pupils' scores of ecological and environmental knowledge were higher in east lake villages (Ambodivoara and Andreba) in comparison to those in the west (Andilana Sud and Anororo) (41 vs. 31). An unpaired *t*-test indicates a significant difference between the scores from the east and west villages $F(8, 320) = 8.32, P < 0.001$.

From Figure 3, it can be seen that in comparison to the other three villages, the Anororo school pupils' scores were very low in both the Experimental and Control groups, and these did not differ significantly from each other. However, teachers from Ambaton-drazaka reported improvements in the children's knowledge about the importance of lemur conservation and the threats to their survival in forest and marsh areas.

All teachers reported that children spent considerable time discussing the content of the comic book with their friends and stated that they enjoyed the story. In the second teacher-trainer workshop, teachers were encouraged to propose ideas to improve the tools for didactic purposes. Their suggestions included documentary films, videos, and posters to further generate curiosity amongst the children and encourage interesting discussions.

Discussion: Madagascar Wildlife Conservation's Alaotra Comic Book Project

In general, the children in the Experimental Group had higher scores than those in the Control Group. Examining the Control Group results alone, it can be seen that the pupils' ability to answer questions, on the questionnaire, displayed some knowledge of the ecological and environmental issues surrounding the habitat and survival of the Alaotran gentle lemur, results that were even more enhanced in the Experimental group. Together, these results indicate that there is a foundational basis on which to build greater awareness of conservation issues for the lemurs and other endangered species in the marsh/lake environment. The data from the Experimental Group in comparison to that of the Control individuals suggests that this foundational knowledge can be increased with the use of the comic books and class discussions.

Various reasons could explain the low scores and lack of differences between assigned testing groups in the east vs. the west villages, particularly the village of Anororo. A most likely explanation stems

from the Anororo school teachers not attending all of the training sessions provided by the MWC team. Lack of sufficient training and individual knowledge may have hampered their efforts to effectively introduce ecological and conservation information about the bandro and its habitat to their pupils.

Further efforts to both enhance pupils' knowledge and also to fine-tune the questionnaire will be pursued. In the latter case, the questionnaire may be refined to further evaluate general principles of environmental and conservation knowledge, and changes in attitude that were not present in the questionnaire used. In addition, tests of "before" and "after" exposure to the "comic books+workshop/class discussions" and with a more equal number of students in the Control Group and the Comic Book Exposed Group will be conducted. Both designs (within and between subjects) should provide a rich dataset for examining utility of the "comic book+workshop/class discussion" method to facilitate greater knowledge and change of attitudes/behavior in local populations.

Follow-up interviews with teachers will be carried out as well as a survey of adults in these communities to determine which conservation tools are most effectively used by teachers to broadly effect local communities.

Preliminary results from this project suggest that comic books may be a useful method for facilitating conservation and ecological knowledge in schoolchildren. Other methods are also encouraged, especially for the many children and adults who do not attend schools. These other methods include presentations of colorful posters and working with the pupils and adults to create their own short stories or poems about lemurs, the marsh in Alaotra, and the importance of biodiversity in general.

The Ako Project: Storybooks and Posters for Conservation

Methods and sites

The Ako Project aims to bring supplementary educational materials to Malagasy schools. Although reading, writing, and schooling were introduced in Madagascar in the nineteenth century [Rakotoanosy, 1986], many children still have little or no contact with books. The Ako Project has produced six books that are fun to read and with beautiful illustrations. The stories tell adventures of an aye-aye, a Madame Berthe's mouselemur, a ringtailed lemur, red ruffed lemur twins, a Decken's white sifaka, and an indri (English author A. Jolly, Malagasy author H. Rasamimanana, artist Deborah Ross, designer Melanie Kirchner McElduff). Accompanying the books are posters of the ecosystems where these lemurs live. These posters are created by artist Janet Robinson and by the Group d'Étude et de Recherche sur les Primates (GERP; the Malagasy Primatological Society) with the Ako Project scientists.

The Ako Project is a collaboration between École Normale Supérieure of Antananarivo (ENS), Durrell Wildlife Conservation Preservation Trust (DWCPT), and GERP.

Of course, it is not enough to simply offer materials. Their reception and use must also be evaluated and aid offered to teachers to make the best use of the material. Here, we discuss teachers' and students' reactions to the first book, *Ako the Aye-Aye* [Jolly, 2007], and workshops with teacher-trainers to elaborate lesson plans for the use of reading books. In evaluating the effectiveness of this first book, the following hypotheses are tested: (1) Malagasy children do not seek to read because they have few opportunities to read. However, the children are happy to have lovely, colorful books; (2) Malagasy children appreciate learning about an unknown animal living in their country, but know little about biodiversity; (3) many Malagasy teachers do not understand that they can use a nontextbook for a school lesson; and (4) senior educationalists can assist in training teachers to develop effective lesson plans.

Two thousand books of *Ako the Aye-Aye* were distributed in dozens of rural primary schools in six areas of Madagascar in 2007–2008. Twenty books were given for each school library. In addition, the three best students in each class received copies as prizes (Fig. 4).

The four Ako Project evaluation sites were in areas where DWCPT works and conducts conservation education within the community. Ambatondrazaka on Lac Alaotra is a RAMSAR site, Madagascar's largest lake, and is located 270 km east of the capital city, Antananarivo. It is also Madagascar's chief rice producing area, often called the "rice silo," and one of its most eroded landscapes with gullies (*lavaka*). Moramanga is a city located 100 km east of Antananarivo and 20 km from the rainforest, National Park of Andasibe, famous for tourists and scientists' access to Madagascar's largest living lemur, the indri. Manombo is a littoral forest in the southeast



Fig. 4. A class in Ivoloïna Education Center reading the book, *Ako the Aye-Aye*, before receiving prizes. Photo, Ando Ratovonirina.

of Madagascar, 547 km from Antananarivo, site of a long-term research project on *V. variegata*. Morondava is a city in the western Menabe Region, 500 km from Antananarivo. Kirindy forest with its lemur research station (Kirindy Forest) is about 60 km from Morondava.

In 11 primary schools at the four test sites, ENS masters students in teacher training held two-hour workshop discussions with each of the pupils and teachers based on reading the *Ako* book together. They then gave standardized questionnaires to 381 pupils and 40 primary school teachers (pupils were at the 5th grade level, mean age of 13 years, ranging from 8 to 17). Two hundred and seventy-one pupils came from six schools in Ambatondrazaka, 40 came from three schools in Manombo, and 70 from two schools in Morondava. Results are given as a percent of the answers, because the children could choose more than one answer. Many questions were not answered, especially in the open questions that did not have multiple-choice answers. These open questions required greater thought and also the ability to write. With only 40 teachers included in the sample, this pilot study provides only indicators in evaluating the effectiveness of teachers imparting ecological and environmental information to their pupils.

GERP also gave workshops for senior educational administrators in Moramanga and Ambatondrazaka. They elaborated lesson plans on the use of supplementary materials, with the book, *Ako the Aye-Aye*, as an example; Table IV presents the educators' qualifications. GERP members brought *Ako* books for all participants, posters of aye-ayes and other lemurs, lemur and reptile guides, power-point slides, and facilitated the discussion.

RESULTS

Ako Project: Outcomes from Pupils' and Teachers' Questionnaires

Pupils' answers

How many books have you read? Half of the pupils had read more than one book, and nearly 4 in 10 had read more than 10 books in their lives (this includes school texts and the Bible). One in 20 children reported that the *Ako* book was the first book they had ever read. Most pupils had been offered more than one book in their lives, but 1 in 20 had never been offered any (Fig. 5).

Did you like the Ako the Aye-Aye book? Ninety-five percent of children said "yes"; but when asked *Why?*, 60% just stated it was "nice." Specific answers included "instructive," "about animals," "the story matches the pictures," or for dislike, "scary"; 1% reported "the book is very colorful," 5% reported "it is a very new thing never seen before"; and 14% gave no answer.

What type of books would you like to read? Eleven categories of books were offered and more than one

TABLE IV. Background of the Educational Trainers Conducting Workshops for the Ako Project

	Ambatondrazaka		Moramanga	
Number trainers	20		20	
Trainers' background	Ten school directors	Six heads of the zone of pedagogical support	Ten school directors	Six heads of the zone of pedagogical support
Trainers' academic level	Sophomore in education	Sophomore in education	Sophomore in education	Sophomore in education
Trainers' teaching experience	20 years	26 years	20 years	26 years
Number of GERP members	3		3	
GERP member academic levels	3 Masters Degree		1 PhD and 2 Masters Degree	
GERP member teaching experience	8 years		24 years and 2 years	
	Four pedagogical counselors and administrators		Four pedagogical counselors and administrators	
	Bachelor		Bachelor	
	5 years		5 years	

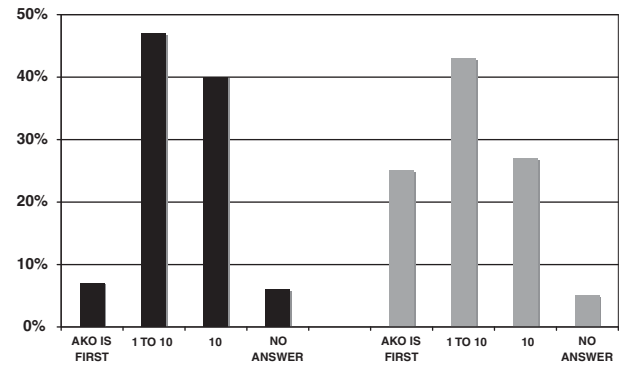


Fig. 5. Number of books final year students had read (black) or been offered (grey). *N* = 241 pupils from 11 primary schools; pupils were at the 5th grade level, mean age of 13 years, ranging from 8 to 17.

category could be chosen. Two percent did not respond, but most children (44%) chose manuals (textbooks), 20% religious books, 15% stories, and 13% chose comics. Sixty percent of children said they would take time to read a book and 71% said they would read only when they did not have anything else to do.

Would you lend your book? Why? Overall, 63% agreed to lend their book; 34% did not agree; and 3% gave no answer. Three concepts shaped children’s willingness to lend a book that belonged to them: trusting, sharing, and empathy.

What did you learn from the book? Fifty percent reported that “it improved my understanding of animal protection or of the aye-aye itself” or “it makes me want more animal stories,” whereas 25% reported that it improved reading or vocabulary. Twenty percent stated that “it makes me want to tell the story to others” or “it makes me want to draw and design” (Fig. 6).

Why do aye-ayes eat coconuts and what to do about it? Forty-six percent stated the coconut is the aye-aye’s main food; 27% reported because their forest is being destroyed; and 27% said either for fun or to annoy people. As for solutions, 68% gave no answer. Those that did answer were fairly evenly split between reforestation, plant more coconuts, and fence the plantation—though having read the book they should have learned that aye-ayes are arboreal and would ignore fences.

General conservation knowledge: Knowledge varied enormously by area. Children in Manombo, near a forest, knew many of the kinds of lemurs endemic to the area. City children, even those living near reserves, had rarely visited the forest and knew little. The book was presented along with a poster of aye-aye photos, and the children thought real aye-ayes ugly and scary, the ones in the book much cuter.

Teachers’ answers

What is the environment? Fifty-seven percent included both wild and human environments; 43%

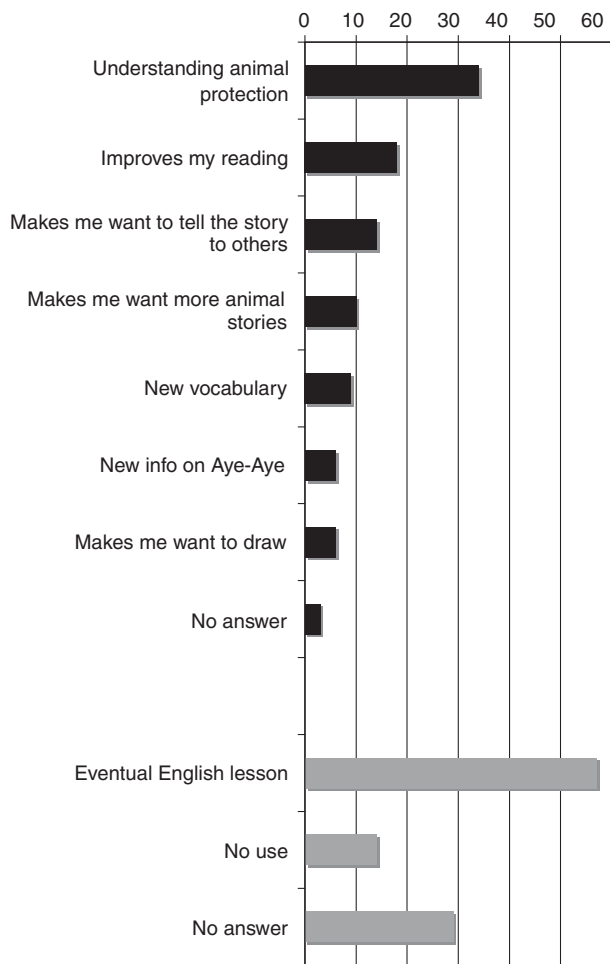


Fig. 6. Percent answers to “Is the *Ako* book useful? Why?” by final year primary pupils (black) and primary school teachers (grey). Pupils $N = 241$, Teachers $N = 40$, 11 schools. The pupils had clearly discussed the book while the teachers had not, but teachers could not spontaneously see any use for an environmental storybook in school teaching.

mentioned only wild forest and marsh; some added that this is the concern of some particular persons, but not themselves.

What are the consequences of environmental destruction? Sixty-six percent responded “climate change,” meaning not global climate but their own experience of loss of land productivity, decreased rainfall, hotter summers, and colder winters. Thirty-three percent responded “loss of wild species.”

Who is in charge of conservation education in your area? Forty-four percent chose all six possible answers including NGO organizations that do not operate in their area, whereas 42% responded themselves as well as the local VIP.

What methods are used for conservation education? All (100%) selected categories of reading, news broadcasts, and school.

Do you use interactive teaching methods? [A method called *Ecopedagogy*, developed by World Wildlife Fund; see also Kahn, 2010]. Seventy-one

percent reported positively; 29% reported they were trained in the method but do not use it; 43% selected all possible answers offered for its objectives; another 43% selected all answers except the correct target answer. Only 14% chose the target answer: to encourage students to be responsible for their own analyses and decisions.

How do you help pupils who do not understand? All teachers reported they provide correct answers to help the pupils understand; 100% also stated they provide extra teaching time (for two hours) after school for students who pay. No teacher reported that they tried to improve the children’s capacity to think critically and analytically for themselves.

*Is the *Ako* book useful for teaching and why?* Eighty-six percent reported the *Ako* book is very useful; 14% reported no use. When asked why, 57% suggested the *Ako* book’s possible usefulness for teaching English, and 29% gave no answer. None mentioned understanding animals, conservation, or encouraging reading (Fig. 6).

Educational administrators’ workshops

One goal of the workshops was to design a poster for GERP to assist in illustrating concepts and maintaining pupil’s interest. The poster includes children, endemic species, ecological concepts, and three lemur species: aye-aye, eastern sifaka, and dwarf lemur, presenting their habitat, behavior, and coexistence in a single ecosystem.

The second goal was to develop diverse lesson plans for teachers by means of the *Ako* book. Participants in the two workshops chose to emphasize different approaches. In Ambatondrazaka, they focused on teaching life sciences and geography. The Moramanga workshop was more wide-ranging. They considered using the *Ako* book to teach official Malagasy, art, life sciences, and physical education, and included such questions as: “Can you use your fingers like an aye-aye? Hear echoes? Run quadrupedally, leap, and hang by your feet?” From discussion with teachers, it was clear that senior educational administrators could develop creative lesson plans that teachers would implement if there were support from the Ministry of Education.

Most questionnaire responses on the usefulness of such a book concerned ecology, Malagasy culture, and citizen’s education. Specific knowledge about the aye-aye only received 9% of responses, and only 20% remarked on the fact that dwarf lemurs hibernate. When asked why animals should be conserved, 50% of the educational administrators viewed them as a heritage to leave for the descendants. An interesting difference was that 43% in Moramanga cited endemicity compared with 15% in Ambatondrazaka: Moramanga benefits from tourist trade.

Almost all the educational administrators stated that the workshops had brought new information and ideas, and that workshops should be held twice a

year. However, when asked for further suggestions, they focused on materials or teaching of workshops; only 9% mentioned raising teachers' or pupils' motivation for environmental education. Those few stated that teaching could go no further without specific motivation, notably the inclusion of environmental education in the national curriculum. They also declared their belief that only if all the NGO's worked together, this could happen.

DISCUSSION

The Ako Project

Madagascar is a country where children inherit an oral tradition and teachers inherit a tradition of rote learning and teaching [Ayache, 1976]. There have been many attempts to add increased literacy and literature to the culture, but none have succeeded so far. We found that children have few books, but do like beautiful books and learning about animals, which primary school teachers have little idea how to use supplementary books, and that educational administrators can indeed draw up lesson plans for teachers' use.

The results so far offer both hope and realism. Half of 13-year-olds had read or been offered less than ten books in their lives, including the Bible and school texts. For 5%, the *Ako* book was their first book. School libraries are generally nonexistent or have books unused, still tied together as when they were shipped to the school. Many teachers and students are unclear about what is meant by the "environment." Perhaps, the most telling difference is between the children's and primary school teachers' answers to "What use is the *Ako* book?" Children said they had learned about animals, learned new language and vocabulary, and were stimulated to tell stories and draw their own pictures. Most teachers could provide no use except possibly to teach English. It appears that long years of discouragement, poor pay, and lack of support have left primary school teachers with little motivation, except to provide basic pedagogy and teach after-school lessons for paying students. Because education usually has a generation's time lag, the single greatest need is more support in all ways, both mental and material, for the existing teaching staff.

In contrast to the primary teachers, the educational administrators created a series of lesson plans based on the *Ako* book about biology, language, and physical education. It was clear, however, that environmental education must be included in the national curriculum before teachers would be motivated to teach it.

General Discussion

Although the culture of Madagascar is primarily based on oral traditions, the Office National pour l'

Environnement has produced books as a guide for environmental education and active biodiversity learning. These books argue that lemurs, as a flagship species, are the most appropriate and best didactic tool for teaching Malagasy students to become proactive in conservation. Conservation knowledge is founded in scientific knowledge and reasoning. Books in general provide a valuable basis for science learning and capacity building for teachers and pupils particularly, and are an excellent reference source to return to over a period of time (as opposed to an oral presentation of information) [Kahn, 2010]. Factual information linking, for example, ecological webs, long-term effects of deforestation, and other scientifically based conservation issues, can be illuminated most effectively using printed materials [Kahn, 2010]. This also would include posters that represent ideas in pictorial and diagrammatic formats, which oral presentations (e.g., over the radio) could not provide alone [Jacobson et al., 2006], and culturally appropriate evaluation methods for knowledge-based and environmentally related value changes [Kuhar et al., 2007].

Based on our questionnaires and interviews with teachers, it appears that knowledge about lemurs and other endemic species in the general population in Madagascar is limited. For example, few students knew that lemurs are varied in color and size, that species have different morphology, physiology, locomotion, behavior, and social organization, and that there are significant differences between diet, activity patterns, vocalizations, geographical distribution, and adaptations to habitats of different species. From the personal observations of the authors, it is clear that the general population does not yet have an appreciation of the uniqueness and diversity of lemur species, and when asked, few people realized that lemurs occur only in Madagascar.

For many areas, particularly in rural areas with very low literacy rates, incorporating the oral tradition (in addition to written materials) in the process of environmental education is also of considerable use. Thus, songs, poems, dances, and sketches on environmental and conservation themes can be used to supplement other materials. These "tools" are appropriate both for children and adults.

The Ministry of Education has worked with educators from NGOs (World Wildlife Fund and others) to produce biodiversity education books. Many NGOs write books or produce posters that the Ministry of Education gives its approbation to be used at schools. These are hopes for the future conservation in Madagascar. Therefore, the authors propose various ways in which the Ministry should encourage the study of biodiversity and environment into the curriculum:

1. *In primary school:* Through the use of age-appropriate books, students should learn about

the endemic fauna and flora of Madagascar, including different species of lemurs subfossils (extinct species) that live and lived in each province and different habitat types (rainforest, dry forest, spiny desert, marsh), and about these species conservation status. Madagascar remains a predominantly rural country, so human dependence on climate, water, soil, and wood for fuel can be integrated with traditional knowledge with the addition of information about the nation's unique biodiversity. Because most children do not continue to secondary school, the concept of interrelations within an ecosystem and of human dependence on the natural ecosystem should be introduced at this level. The use of colorful, interesting, and informative pictures, photographs, and diagrams are important aids in imparting this perspective and linking basic factual knowledge into a web of understanding.

2. *In secondary school*: The junior students should learn about behavior, diet, locomotion, and social organization of lemurs and other endemic species, as well as the local flora. The seniors should learn about the phylogeny of lemurs also in relation to the nonhuman primates of Asia, Africa, and South America. The initiation of the concept of Anthropology should start at this level. Learning to place themselves within the Order Primates will help underline the connectedness of all species, including humans, within the ecosystem, as is emphasized in the three case studies presented in this article.
3. *At University*: A Conservation Biology Department should be created that collaborates with those in teaching, to bolster capacity-building particularly for science teachers around the country. Collaboration between departments should be promoted.
4. Students and faculty should be encouraged to write and publish scientific articles, both individually and collaboratively, with published colleagues from other countries, to take part and make an impact as members in the international world of science.

NOTE ADDED IN PROOF

Corrections were made after initial publication to the following sections: Author Affiliations; Page 8 (line 46R); Acknowledgments (lines 58L, 1-5R).

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