PROGRESS REPORT

Submitted by James Mwang'ombe, Project Manager

Restoration of Sagalla Hill with a view to creating a sustainable future for the Critically Endangered caecilian *Boulengerula niedeni*

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Figure 1: *Boulengerula niedeni* is a recently described caecilian from Sagalla Hill in south-east Kenya and has a Critically Endangered status due to the deteriorating environment in its very small area of occurrence.

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Executive summary

Boulengerula niedeni is a recently described species of caecilian amphibian judged to be Critically Endangered due to the ongoing degradation of its very small area of occurrence of less than 2 km^2 on Sagalla Hill in south-eastern Kenya. The EDGE of Existence Programme at the Zoological Society of London (ZSL) has chosen the Sagalla caecilian as a focal species for conservation action on the basis of its evolutionary distinctiveness and threatened status. This species thrives in moist, black, fertile soil in forests and small agricultural holdings, but on Sagalla these habitats are dwindling due to a combination of increasing population, soil erosion through bad agricultural practice, and the spread of invasive *Eucalyptus* trees. The future of this species rests in the reduction of soil erosion, and replacement of introduced *Eucalyptus* and pine trees with indigenous plant species, providing a reserve for the species. At the same time, removal of *Eucalyptus* will provide water for inhabitants of Sagalla, reduce soil erosion and increase awareness of responsible farming activities. In essence, what is good for the caecilian is good for the sustainable future of farmers on Sagalla Hill.

Figure 2: A Local Treasure – *The entire school on Sagalla Hill are shown the Sagalla caecilian by Bigvai Mwaizango (amphibian conservation worker) whilst a local forestry official explains the importance of this species to Sagalla.*

Introduction

ZSL's EDGE of Existence programme

Conservation priority setting based on phylogenetic diversity has been frequently proposed but rarely implemented. The EDGE of Existence Programme (www.edgeofexistence.org) at the Zoological Society of London (ZSL) has defined a simple index that measures the contribution made by different species to phylogenetic diversity and uses this index to define species-based conservation priorities (Isaac *et al.,* 2007). The approach has been applied to a near-complete species-level phylogeny of the Mammalia to generate a global priority list incorporating both phylogenetic diversity and extinction risk. It was subsequently used to define a priority list for the Amphibia (Meredith *et al. in prep*.) based on the most complete phylogenetic information available (Frost *et al.,* 2006; Roelants *et al.,* 2007). The 100 highest-ranking amphibian species represent a high proportion of total amphibian diversity and include many species not usually recognised as conservation priorities. A large proportion of species that are both Evolutionarily Distinct and Globally Endangered (EDGE species) do not benefit from existing conservation projects or protected areas, with 85% of the top 100 amphibian species receiving little or no conservation attention. Now in its second year, EDGE is forging ahead with conservation projects for focal amphibian species, including the Sagalla caecilian (*Boulengerula niedeni*) – currently known to be the world's most threatened caecilian species.

Figure 3: EDGE Amphibians – *purple frog (Nasikabatrachus sahyadrensis); Gardiner's Seychelles frog (Sechellophryne gardineri); Malagasy rainbow frog (Scaphiophryne gottlebei); Sagalla caecilian (Boulengerula niedeni); Chinese giant salamander (Andrias davidianus)*

Sagalla caecilian

Measuring up to 30 cm in length and only 0.6 cm in diameter, *Boulengerula niedeni* (the Sagalla caecilian) superficially resembles a brown earthworm, and the farmers of Sagalla refer to them as 'm'gnori' (earthworm). But a second look will reveal that they move more like a snake keeping a constant length and a closer inspection will reveal a prominent mouth and a pair of tentacles and nostrils (or nares), and local farmers do acknowledge their difference. Indeed, *B. niedeni* feed on earthworms, termites and other invertebrates that live in the soil. While these amphibians rarely move above ground, they are occasionally encountered by farmers when digging on their shambas (small agricultural holdings), and are seen as a sign of rich, fertile soil.

Figure 4: Sagalla caecilian (*Boulengerula niedeni*) – *alone (left) and with Leptotyphlops scutifrons merkeri (black in colour) showing the superficial resemblance to a typhlopid snake (right)*

B. niedeni has been found in the greatest numbers on shambas. They are most commonly encountered in the dark moist soil, such as that which is manured by cattle dung (from zero grazing). Some farmers have complained that while they used to have both caecilians and black soil, both have now gone due to erosion. The only *B. niedeni* found in reproductive condition so far were within the stream banks in the hanging valley of Sagalla Hill. Although it is likely that caecilians are breeding elsewhere on Sagalla, their relatively high densities in the central valley places an important emphasis on this area for their conservation. This same area is under very heavy pressure for agriculture and suffers markedly from soil erosion.

B. niedeni have been found within the indigenous forest patches inside the government plantation, but at very low densities. However, despite many searches, there have been no Sagalla caecilians found within pine or *Eucalyptus* plantations. Investigations into soil macrofauna (invertebrates such as earthworms, ants and termites) have shown that the plantations are considerably depauperate, with neither earthworms nor termites found. This is likely to be due to the toxic nature of the *Eucalyptus* leaf-litter which has no indigenous detritivores. This alone would be enough to inhibit predators such as the Sagalla caecilian. In addition, the soil beneath the *Eucalyptus* is also significantly harder likely as a consequence of soil erosion and the missing soil macrofauna. This makes burrowing much more difficult for subterranean species such as the Sagalla caecilian. *Eucalyptus* is also famed for its thirsty nature. The consequence of exotic *Eucalyptus* plantations on local ecosystems has been disastrous, drying streams and soil alike.

In Sagalla, soil erosion and the large stand of exotic *Eucalyptus* trees are the major impediments to the long-term survival of *Boulengerula niedeni*. Stabilisation of soil can be made through better agricultural practice and strategic forested patches. However, simply removing *Eucalyptus* is not a sustainable solution. The area needs replanting with indigenous trees which can provide a permanent reserve for this Critically Endangered amphibian.

Taita Hills Hotspot in the Eastern Arc Mountains

The Taita Hills (south-east Kenya, 03°20'S, 38°15'E) represent the northernmost extreme of the Eastern Arc Mountains, a chain of mountains that run from south-eastern Kenya to southern Tanzania and boasts an extremely high diversity of flora and fauna, high levels of endemism, and high threat levels. The area is part of a global biodiversity hotspot and is part of the Tanzania-Malawi Mountains Endemic Area. The overriding conservation problem in the Taita Hills and other biodiversity hotspots within the Eastern Arc region is loss, fragmentation and degradation of the indigenous forest cover. Indigenous cloud forest in the Taita Hills currently covers an area of about 430 ha, reflecting an estimated 98% forest reduction over the last 200 years, mainly due to clearance for agricultural purposes (Newmark, 2001). Although forest clearance is less widespread at present, past clearance led to increased isolation of the remaining patches, edge effects, soil erosion and negative hydrological effects. Despite the small size of the 12 remaining indigenous forest fragments, they are of global conservation importance, holding numerous rare and endemic plants and animals. Since many of these species persist in small and highly isolated subpopulations, a high proportion is highly threatened and is of immediate conservation concern (demographically and/or genetically).

Approach

In this application, we seek funds to employ a project officer for a period of one year to interact with the people of Sagalla in order to raise awareness of the problems in their environment, produce sufficient data for a forest management plan, practically advise of best agricultural practice to minimise soil erosion, and provide incentive to remove *Eucalyptus* trees from private shambas. In addition, we are seeking funds from other sources to investigate soil erosion and plan for strategic intervention.

We believe that the only viable solution to the long term conservation of *Boulengerula niedeni* is to halt soil erosion and to convert the existing government plantation in Sagalla from exotic *Eucalyptus* into an indigenous forest. Simultaneously, heightened awareness of the *Eucalyptus*

trees on private land and the problems that the area faces with soil erosion should create a more sustainable environment for caecilians and Sagalla farmers alike.

Timely

This application is timely as attitudes towards government forests in Kenya have changed in recent years. The Forest Act of 2005 provides for the possibility of harvesting and replanting government plantations with indigenous forest under the new Kenya Forestry Service (KFS). Previously this was impossible following a presidential decree outlawing cutting of any government owned trees. That the project is feasible has been shown by East African Wild Life Society's (EAWLS) James Mwang'ombe who has collaborated with KFS and local people on nearby Mbololo to plant over 90,000 indigenous tree seedlings into a government plantation, Mwambirwa, and also in Chawia forest where 65,000 indigenous tree seedlings have been planted. The Taita Hills can be seen as leading the way for Kenya in this respect as plans are already underway with the same CEPF funded (Project Title: Forest restoration to enhance forest connectivity in Central Dawida for biodiversity conservation in Taita Hills; A preparatory phase) consultation exercise that we describe below to transform four more government plantations on Dabida. Secondly, on Sagalla itself, the people have experienced their first year (2007) without any groundwater in the dry season. Wells and boreholes dried up due to the ongoing spread and growth of *Eucalyptus* trees. Many people are aware of the association and are asking EAWLS for help to change the government plantation. Lastly, aid organisation WorldVision have expressed an interest in funding tree seedling nurseries and planting using local labour. They do not, however, have funds to finance the necessary initial phase of research and preparation.

The momentum, expertise and awareness are growing in the area and we believe that it is the ideal opportunity to launch this project on Sagalla to safeguard the future survival of the Critically Endangered *Boulengerula niedeni*. As an unprecedented extinction crisis threatens to obliterate a third of all amphibian species (GAA/IUCN Red List 2008; Mendelson III *et al.,* 2006; Stuart *et al.,* 2004), there has never been a greater necessity to conduct research and active measures that seek to conserve amphibians in the wild. Furthermore, an alarming 66% of all known caecilian species categorised as Data Deficient by the 2006 Global Amphibian assessment (GAA/IUCN Red List 2008). A concerted and holistic conservation effort for the Sagalla caecilian could act as a flagship project, demonstrating how a little-known and previously under-valued species can unite a local community in habitat restoration and sustainable environmental management.

Background Information

Study site

The Taita Hills lie in south-eastern Kenya at 03°20´S, 38°15´E, about 150 km inland from the coast, and cover an area of about 250 km^2 (Brooks *et al.*,1998). Geologically, they are the northernmost part of the Eastern Arc Mountains (Lovett 1998; Lovett and Wasser 1993), a global biodiversity hot-spot (Myers *et al* 2000) and part of the Tanzania-Malawi Mountains Endemic Bird Area (Stattersfield *et al.* 1998) The Taita Hills massif is isolated from other highland blocks, the closest of these being 80 km away, by the semi-arid plains of Tsavo West National Park (600-700 m).

Figure 5: Sagalla Hill looms over the semi-arid Tsavo plain

The Taita Hills forests have been fragmented for a long time, but large-scale forest loss has mainly occurred since the 1960s, reaching critical levels in recent years (Brooks *et al.* 1998). During this time, the once extensive indigenous forests have been encroached upon leaving only small remnants on hilltops, while the denuded hilltops and hillsides (unsuccessfully cultivated after clearing natural vegetation) have been reforested with exotic trees (Beentje and Ndiang'ui 1988). The present landscape consists of three distinct isolates: Sagalla Hill (1,520 m, separated from the rest of the massif by a valley at 700 m), Mbololo Hill (1779 m, separated from Dabida by a valley at 900 m) and Dabida Hill (including the highest peak Vuria at 2,208 m). Twelve indigenous forest fragments are distributed across the three massifs, scattered on hilltops and ridges and surrounded by a mosaic of human settlements, small-scale cultivation plots and plantations of *Pinus*, *Eucalyptus*, *Cupressus* and *Juniperus* spp. On Sagalla, only a c.4 ha indigenous forest patch remains.

The patch of community-owned indigenous forest lies along the upper most ridge and South-east facing slope of Sagalla. This forest has suffered heavy loss from recent cutting of large trees (Wilder *et al.*, 1998) as well as smaller saplings and is already suffering from invasion by *Eucalyptus* (John Measey pers. obs.). This forest is under the control of a local committee that sanctions any timber extraction. In practice, this area is heavily used for harvesting of fallen wood and saplings for building poles. The Sagalla caecilian has been found in this natural forest, but in low numbers, and appears to rely (as elsewhere) on the fertile black soil which results from the rotting fallen timber. Removal of this material is of detriment to the whole forest ecosystem in its renewable fertility, as well as the detritivorous invertebrates that feed on it and their predators (like the Sagalla caecilian). In addition, the forest has become a warren of small paths which lead to their own problems, allowing invasive exotics in as well as compacting soil.

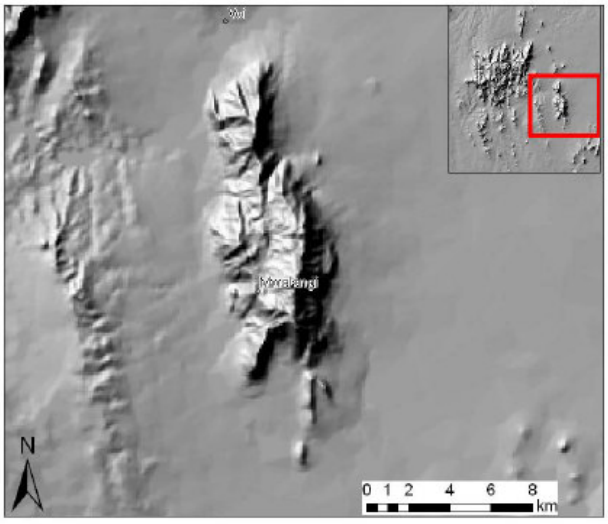
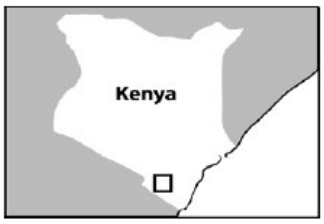


Figure 6: This map shows the position of Sagalla in relation to the nearby Taita Hills, Dabida and Mbololo (to the West)

The coastal town of Mombassa lies 130 km to the southeast.

Sagalla Hill is very small and the amount of indigenous forest remaining has been estimated as only 2 ha.



Prior research

B. niedeni, was described in 2005 from a small series of 11 specimens collected from a single locality on Sagalla Hill in early 2004. The description of this new species (Müller *et al.*, 2005) focused on morphological differences between *B. niedeni* and other species in the genus *Boulengerula*. They described differences in annulation (the number of distinctive skin folds that make caecilians appear superficially like earthworms), tooth counts, and the phallodium (a penis like organ that males use to transmit sperm). Differences between the Sagalla caecilian and the only other caecilian known in the area, the Taita Hills caecilian (*B. taitanus*) were immediately apparent as the distinctive blue-black patterning on the Taita caecilian is absent on the Sagalla caecilian which is a dull muddy brown. Müller *et al.* (2005) concluded that based on their very few specimens "The currently limited information about *B. niedeni* implies that it should be considered 'data deficient' (using IUCN 2001 criteria). However, as all specimens were collected in an

anthropogenically disturbed area on a small, isolated mountain, it is clear that detailed future investigations are needed."

Prior conservation action

In November 2005, a CEPF (www.cepf.net) funded project run by herpetologists John Measey (SANBI, South Africa) and Patrick Malonza (NMK, Kenya) initiated a detailed inventory and assessment of the amphibian diversity in the Taita Hills with a focus on species that were considered to fall into IUCN 'threatened' categories (Malonza *et al.* in prep). The project employed a small group of local Taita and Sagalla people to capture and identify local amphibians, creating much needed awareness about these organisms, besides providing some employment and collecting invaluable scientific data. At Sagalla, an emphasis was placed on obtaining good distributional data for the Sagalla caecilian, as well as an estimate of its abundance in different land uses.

At the time of writing, this project is reaching completion in December 2008, we have detailed information on distribution and relative abundance but are still gathering information on the exact nature of breeding and dispersal of *B. niedeni*. Ongoing work includes using aerial images from 1956 to present of the area to map changes in land use, and hence the changing distribution (using projected models of occurrence with MAXENT) of the caecilian within Sagalla.

Ongoing situation

Traditionally, shambas are passed from fathers to sons and contribute significantly to the income, both in nourishment and cash, of most Sagalla families. Over the past three decades, population numbers have increased dramatically on Sagalla such that previously unutilised land has been converted into shambas, and existing shambas have been subdivided into many smaller plots. This has resulted in the cultivation of land on unsuitably steep slopes leading to erosion of topsoil despite partial terracing. This has also meant that areas that would otherwise be left fallow are now being cultivated every season. Besides, shambas bordering streams have been cultivated right to the edge, disregarding the need to have a stream buffer zone. Consequently, erosion is prevalent and counter-productive, eventually reducing the effective farming areas.

As normal water supplies have dried, residents have taken to digging down to the water table in order to get irrigation water, water for domestic use and livestock. Each year the holes become deeper and deeper. In 2007, there were initial reports that some holes had completely dried up; water supply for some residents has reached a crisis point.

Sagalla Land-use

Sagalla Hill has three basic land uses which can be summarised best as 'shambas' (small agricultural holdings), arboriculture and grazing. Other land uses, such as roads, buildings and natural forest, cover such small areas that we do not consider them to be significant to the outcome of any current conservation effort. Some issues regarding the remnant natural forest at the hill top will however be discussed later.

Shambas cover a large proportion of the settled area on the hill and a bulk of the distribution of the Sagalla caecilian. Shambas in this area are hand-tilled using hoes. The common crops cultivated include maize (*Zea mays*), bananas (*Musa* sp.), avocado (*Persea americana* Mill.), sugar cane (*Saccharum officinarum* L.), yams (*Dioscorea* sp.), tomatoes (*Lycopersicon sculentum* Mill.), beans (*Phaseolus vulgaris* L.), cassava

Figure 7: Shambas on Sagalla Hill – *in the distance you can see Mount Kasigau*

(*Manihot esculenta* Crantz) and guavas (*Psidium guajava* L.). Additionally, many households are in possession of one or more cows on a 'zero grazing' scheme whereby they bring fodder to the cows which are (almost) permanently corralled in a small enclosure. Manure from the cows then passes back onto the land.

Arboriculture: arboriculture was sold to residents as a cash crop in the 1980's. Unfortunately, the choice tree species was a *Eucalyptus* sp. Trees have grown and removed a lot of moisture from the soil. This has effectively lowered the water table and reduced the water flow in streams on the mountain. In addition, shamba owners were told that they would obtain a high price for their timber at maturity (10-20 000 KSh per tree), but due to the glut of *Eucalyptus* in the area, and government restrictions on movement of timber, the price has drastically reduced below the cost of removing the trees and transporting the wood. Most residents know that the trees are responsible for water problems on the hill, but they refuse to give up their investment. Even worse, these trees undergo vegetative reproduction, spreading across the shambas and sucking even more water from the ground. Weeding out seedlings becomes a constant task, and those that become established are very hard to remove. Trees that are cut simply sprout again from their stumps and both land and water continue to be used up.

Figure 8: *Eucalyptus* plantations on Sagalla Hill

In addition to the *Eucalyptus* grown on shambas, Sagalla hill has several private and government *Eucalyptus* plantations. It is possible that the private plantations were planted under the same misconceptions as for the shamba holders. Owners are often absent and nothing is known of their intentions regarding this land. The government plantations (approximately 90 ha) are made up of *Eucalyptus* and pine (*Pinus* sp). Due to a presidential decree banning tree cutting in Kenya in 1985, stands of pine have senesced and are largely in the process of dying. This leaves the land vulnerable both to fire and invasion by *Eucalyptus*. Indeed, *Eucalyptus* is spreading within the government plantation. Small areas (< 1 ha) of indigenous forest occur within the government plantation, largely restricted to areas immediately surrounding streams and water-intake points. However, these areas are also being rapidly invaded by *Eucalyptus* and without immediate action, are likely to be lost.

Grazing mainly by goats on Sagalla occurs on most areas of the hill that are unsuitable for either shambas or arboriculture. As such, grazing sites are of little interest to the conservation initiative we are proposing because they are too dry to support populations of the Sagalla caecilian.

Figure 9: Grazing by goats can lead to soil erosion

EDGE Fellow

EDGE Fellows are promising conservationists from developing world communities who receive support from ZSL to carry out conservation projects for EDGE species. The EDGE Fellows programme identifies in-country scientists, students and local NGO employees keen to develop the skills needed to become successful conservation professionals. EDGE provides Fellows with the financial, technical and organisational support required to carry out novel research into the status and threats facing a particular EDGE species, helping to develop the local expertise to protect EDGE species and, crucially, building in-country capacity at a grass-roots level. Under the supervision of scientists/conservationists at ZSL, local universities and partner organisations, Fellows receive guidance and training in:

- Project planning;
- Monitoring techniques;
- Writing scientific papers and funding proposals;
- Communicating conservation;
- Producing Conservation Action Plans;
- Developing community outreach programmes;
- Education and policy-making initiatives.

Figure 9: EDGE Fellow – *A local conservationist from Sagalla will be supported and trained in research and conservation techniques, building capacity in the region to manage the environmental restoration of Sagalla Hill into the future.*

We have identified a project officer who will become the EDGE Fellow. Dorine Mkaluma Ngeti is from the local area and has a B.Sc. in Environmental Science from Egerton University. She aims to become a leading conservationist in Kenya and will receive substantial in-post training in practical conservation from all five applicants. Her role will include providing regular feedback to EDGE in terms of writing blogs and she will attend a conservation training workshop at the Zoological Society of London after the first year of this project. This opportunity can therefore be considered as a capacity building post for Dorine that will help her realise her ambition of forging a lasting career in conservation. The region has increasing need for experience in this area and this is likely to expand throughout Kenya. In addition, we will encourage Dorine to register for an M.Sc. in conservation science, with the anticipation that she will be motivated to use the Sagalla caecilian as a case-study in conservation.

Project design and methods

Aims:

1. To produce a registered Participatory Forest Management Plan for Sagalla which represents all local stakeholders

2. Removal of *Eucalyptus* from private shambas

3. Prevention of soil erosion through strategic intervention, education of best farming practice

4. Local education

5. Replanting of plantation with indigenous trees to produce a stable reserve for *Boulengerula niedeni* and the reduction of its IUCN status to 'Vulnerable'.

1. Removing Eucalyptus from the Government plantation

A new legislation in Kenya (Forest Act, 2005) entrenches in law the local community's role in forest conservation (see text box), giving new hope for the removal of *Eucalyptus* from the private

and Government plantations. The new act however requires that a Participatory Forest Management Plan (PFMP) be in place in order to guide any activities related to forest use. This management plan must be formulated by the local community in conjunction with the relevant Government body and any other stakeholders. The community needs to form Community Forest Associations comprising all Forest User Groups in order to engage the Government in this participatory process[1]. In the nearby Taita Hills for instance, stakeholders' meetings are currently in the process of preparing a (PFMP) (Morara 2005; Githiru and Lens 2007). Similarly, for this Sagalla project, it will also involve a stakeholders' meeting involving all forest user groups at Sagalla, together with the Kenya Forest Service and other interested parties. This meeting will be the initial activity of the project and will direct the activities of the rest of the programme based on the draft management plan.

Section 46(1) of the Forests Act, 2005 states:
"A member of a forest community may, together with other members or persons resident in the same area, register a community forest association under the Societies Act."

Section 46(2) of the Forests Act, 2005 states:
"An association registered under subsection (1) may apply to the Director for permission to participate in the conservation and management of a state or local authority forest in accordance with the provisions of this Act."

2. Removing Eucalyptus from shambas and private plantations

It is likely that most local people will support removal of *Eucalyptus* from their land due to their role in the current water crisis they face. However, cutting *Eucalyptus* on private lands will be contingent on securing acceptable timber prices, and should also involve poisoning of stumps to prevent regeneration. These activities must be deliberated and agreed upon during the formulation of the umbrella management plan, which will guide actions both within and outside the natural forests and plantations. For instance, it may be decided that shamba owners are offered replacement trees (e.g., indigenous, fruit or other better exotic trees) free of charge for every *Eucalyptus* cut as an incentive. Additionally, most of the proceeds from the sale of the timber must go directly to the land-owners or community projects as will be outlined in the management plan. as scientists and conservation biologists, we will provide technical input regarding the environmentally unfriendly trees to eliminate, suggest replacement species, provide guidance on where to focus different activities based on the caecilian needs, and suggest protocols for doing the replacements.

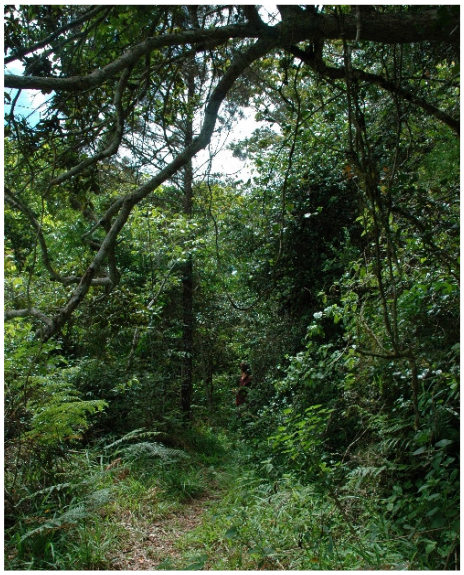


Figure 9: Indigenous forest on Sagalla Hill

3. Prevention of soil erosion

Many farmers in Sagalla may need to be taught how to prevent soil erosion on their farms. In theory, there is already an agricultural extension officer for Sagalla from the Ministry of Agriculture

[1] Community Forest Association: a group of local forest community members (as referred by Forest Act section 3) who have come together and registered under Kenya's Society Act Forest user group: a group comprising members of a local community involved in a particular user activity in a forest or part of a forest Participatory Forest Management: a forest management approach, which deliberately involves the forest-adjacent communities and other stakeholders in management of forests within a framework that contributes to community's livelihoods.

under whose docket this falls. However, due to inadequate finances these persons are often unable to travel around sufficiently to reach most farmers, and thereby little help is ever provided. Areas experiencing the most serious soil erosion shall be targeted first, with individual shamba owners educated on how to change any practices precipitating soil loss. Field workshops and training will also be used for group learning.

Figure 10: Soil erosion on Sagalla Hill

Practical field methods for determining soil erosion have the disadvantage of requiring a lot of resources. However, the fundamental soil erosion model widely used to estimate soil erosion is the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1978). Since its development, other versions such as the Revised Universal Soil Loss Equation (RUSLE) have been derived to estimate soil loss at a plot scale and to predict the effect of different management scenarios on soil erosion (Renard *et al*., 1997). USLE is based on the rainfall factor (R), slope length and slope steepness factor (LS), soil erodibility factor (K), cover management factor (C) and support factor (P), all derived from geospatial datasets and applied in the soil loss calculation. Rainfall factor, slope factor and soil erodibility factors are straightforward to assess if reliable rainfall data, digital elevation models (DEM) and soil maps are available. Support practice is applied if man-made soil control infrastructures are used in the study area. The cover management factor is typically derived from land cover classification, in which each land cover is given a factor, typically so that forests has the highest protective factor value, while bare soil has the lowest. Upon developing the USLE model, the C-factor was defined as the ratio of soil loss from land cropped under specified conditions from the corresponding loss from clean tilled, continuous fallow and in small-area studies in agricultural areas. The C-factor may be defined empirically in the field for each land cover type, as in de Bie (2005).

Figure 11: Cultivating right to the edge – *The pressure for land is so great that no room is left between crops (here maize) and the central stream that runs through the valley. Adult female caecilians are known to nest at this location, but the next rains may wash away this whole bank.*

In the USLE modelling for Sagalla Hill, the C-factor will be derived from a digital object-oriented classification of SPOT satellite image acquired in March 4th 2007 covering the whole Sagalla Hills. The methodology applied for classification will be the same as in Clark & Pellikka (2008). The support factor P will be derived by a visual analysis of terraces in the airborne digital camera image mosaic from March 2003. Slope length and steepness factor will be derived from a digital elevation model, soil erodibility factor from digital soil maps and rainfall erosivity factor from digital rainfall map interpolated using the rainfall data of 10 stations in the Taita Hills between 1987 and 2005. The result of the USLE model is estimated soil loss in the Sagalla hills based on land cover classification, soil conservation activities, rainfall, slope length and

steepness and soil characteristics. The results, which will be of help when targeting the soil erosion control activities, like tree planting and terracing, will be evidenced in the field and using the digital camera image mosaic.

The soil erosion study will be carried out by a M.Sc. student from the University of Helsinki under supervision from Prof. Petri Pellikka. The student will carry out field work twice in the study area, first collecting training data for the remote sensing data analysis, and second for verifying the soil loss results in the field. During the field visits, the student will work together with the EDGE fellow training him for remote sensing, geospatial data management, use of GPS and ground truthing in general. In order to carry out the field work, an extra grant of $6,282.88 is being sought (potentially from WorldVision) applied for this student, which will cover their travel costs and accommodation.

Once areas of high soil erosion have been identified, we will plant small patches of indigenous forests with the consent of local land-owners, in order to strategically slow the worst soil erosion while education of best farming practice is ongoing. Such areas are likely to be surrounding small streams in steep areas, also likely to provide new habitat for *B. niedeni*.

4. Education

Education and awareness rising about the Sagalla caecilian and other indigenous animals and plants at all primary and secondary schools in Sagalla will also be a key component of this project. Students shall be engaged actively in their knowledge of this species and of how it can be a sign of a healthy garden. Other media including games, songs, dances and murals will also be used to help put the message across.

Figure 12: Local Education – *A competition to give a new local name for the caecilian (previously referred to locally as m'gnori, meaning "earthworm") was won by Shali Kiugha (Standard 6 at Lhray Primary School, Sagalla) who suggested the name "Kilima-mrota". In kisagalla, there are several animals which are known as Kilima-something. Each is an elongated animal that moves in the soil surface or amongst leaves and in shallow soil. Mrota means to get thin. As Shali noted, if the caecilian is exposed to sunshine, it gets thin and dies. The prize was presented to her by the area sub-chief, a forestry official and representative of the Environmental Committee.*

5. Habitat restoration and the establishment of a caecilian preserve

Within the framework of the PFMP the newly formed indigenous government forest can be designated as a preserve for *B. niedeni*. Currently the area contains very few caecilians, all of which are within some small (< 1 ha) indigenous forest bordering streams and water catchment areas. The upper boundary of the current plantation is with community owned indigenous forest (around 5 ha) which has also been shown to contain caecilians. This should mean that the caecilians currently living within indigenous forest will be able to expand into newly replanted areas, thereby expanding their range. Once this species has a permanent and undisturbed reserve it will be possible to make a reassessment of its endangered status. We expect that field studies at that time will indicate movement from Critically Endangered to Vulnerable or even Not Threatened status.

Figure 12: Habitat Restoration – *This project aims to build a tree nursery (shown here the successful nursery in nearby Mbololo) to facilitate the restoration of native vegetation on Sagalla Hill*

Expected results and outcomes

- Registration of a Community Forest Association and a completed Participatory Forest Management Plan. This implies the successful outcome of multiple stakeholders' meetings.
- Modalities of doing tree replacement agreed upon with practical work commenced
- Soil conservation improved; numerous farmers reached
- All schools in the area visited by the Project Officer.
- Establishment of seedling nursery, a nursery team and co-funding from WorldVision in place for the second phase of this project.

PROGRESS REPORT - James Mwang'ombe, Project Manager

AWARENESS CREATION

1. Sagalla and Lower Voi River
Activities began with a public meeting in Teri Sub-Location held on 23rd April 2009 and 30th April 2009 in Talio Sub location. Other public meetings were held on 12th May 2009 in Ndara Location and 12th June 2009 in Kishamba location. These meetings were organized in each of the villages surrounding Sagalla forest; several highlights were made on the importance of maintaining indigenous forest cover both for the local livelihood, water catchment function and for the conservation of biodiversity emphasis being made on the conservation of the Critically Endangered Sagalla Caecilian *Boulengerula niedeni* within the area. This will involve raising of indigenous seedlings and planting them in the forests and farms in order to create a reserve for the species

2. Environmental Education
Participated in organization of the world environmental day on 5th June 2009 where over 500 indigenous tree seedlings were planted.

3. Project Manager
Mr. James Mwang'ombe attended a locational Education day in Sagalla presided over by the area Member of Parliament where an opportunity was provided to further create awareness on the need to conserve the water areas for the conservation of critically endangered Sagalla caecilian.

4. Field visits
Field Visits were conducted on 16th-19th June 2009 on familiarization with the Sagalla Caecilian *Boulengerula niedeni* and its occurrence sites.

From previous research it was found in areas with black moist soil under indigenous forest cover and on farms that adjoin the streams. The habitat for the species is decreasing in extent due to invasion/colonization by *Eucalyptus* (replacing indigenous vegetation) and conversion of wet areas (through draining) to farms. It is anticipated that the conversion (or restoration) of the exotic plantations into indigenous forest cover will improve the water situation in the area thus recreating the niche for the Sagalla Caecilian.

PARTICIPATORY FOREST MANAGEMENT PLAN PREPARATION/CFA FORMATION

On 21st June 2009 a visit was made to each of the 4 villages that touch Sagalla forest. Four representatives were elected who will constitute the Participatory Forest Management Planning team and also give representatives for the interim committee of the Community Forest Association. A meeting was held with the Zonal Manager of Taita Taveta of the Kenya Forest Service informing him on the

initiation of participatory forest management for Sagalla forest and requesting him for his support, participation and technical guidance.

TREE PRODUCTION AND PLANTING

An inventory of community groups engaged in tree nursery activities was undertaken. Several groups near the forest were identified most of which are raising indigenous seedlings which will be involved in the rehabilitation of the Sagalla Hill Forest and also supplying tree seedlings for planting on individual farms. The following seedlings were purchased from three groups and planted in schools in Sagalla where students were engaged in their planting and caretaking. The fruit tree seedlings are for on-farm planting in order to increase tree cover while improving livelihood generation. These seedlings are undergoing grafting (to improve quality and production of fruits) before they are supplied to the farmers.

Group	**Type/No of Tree Seedlings**							
	Mangifera indica	***Citrus limon***	***Grevillea robusta***	***Nuxia congesta***	***Mesa lanceolata***	***Prunus Africana***	***Croton Megalocarpus***	***Dovyallis Cafra***
Njama W. Group	500	600						
Mrongo Nyota			550	500	51	52		
Shauri Moyo							300	300
TOTAL	500	600	550	500	51	52	300	300

The groups are also interested in fish farming which is another way of improving the water situation and also an alternative livelihood option which will stop the draining of wet areas for cultivation thus contributing to maintaining/improving the niche of the Sagalla caecilian. The Taita Taveta Wildlife Forum is working in conjunction with the Fisheries Department and are involved in training farmers on Fish farming and pond construction. The demonstration pond is complete and four others are underway.

CAPACITY BUILDING

As part of the capacity building activities and tree planting, a Needs Assessment for Tree nurseries in Sagalla was conducted and the outcome was as follows:

Shauri Moyo

- Have inadequate polythene bags
- Lack of watering cans
- Lack of wheel barrows to transport soil and seedlings
- Lack water storage tank
- In adequate knowledge on raising seedlings on the nurseries
- Are interested in raising sandalwood

Njama Women Group

- Lack water storage facility, the available water comes through the tap that sometimes dries up
- Inadequate watering cans
- Inadequate root pruning tools
- Inadequate polythene bags
- Are interested in visiting other well established tree nurseries

Mrongo Nyota Self Help Group

- Have inadequate polythene bags
- Lack training on tree nursery management
- Are interested in raising fruit trees

Safina Youth Group

- Inadequate water in the nursery site

The results of the Needs Assessment was used to provide assistance (with support from World Vision – Voi Area Development Programme) to the groups which include; watering cans, Jembes, Pangas, Rakes, Polythene bags and spades, and to prepare for a training seminar on tree nursery establishment and management.

From the foregoing, it is imperative that further trainings be undertaken which will cover topics on tree husbandry .i.e. what happens from the tree seedling is planted to maturity. Other topics that need consideration include tree valuation, currently, the farmers sell their trees to middlemen at throw away prices – as low as Kshs 200 (£2) for a tree whose timber will fetch upto Kshs 10,000 (£100).

LAND DEGRADATION ASSESSMENT

Land has continued to face degradation mainly because of inappropriate farming practices on the hillsides and general loss of natural/indigenous vegetation cover. Destruction of hill top forest in Sagalla and the spread of the invasive *Eucalyptus* species have also contributed tremendously to the drying up of most of the springs that serve as catchments for rivers that were once permanent but have now turned seasonal such as Voi River which drains into Aruba Dam in Tsavo East National park important as source of water for the animals.

The Sagalla Caecilian (*Boulengerula niedeni*) is Critically Endangered according to the IUCN red list. Its survival will largely depend on the removal of the *Eucalyptus* and replanting the indigenous trees both on the forest and the farms to provide a reserve for the amphibian. The Sagalla caecilian feeds on earthworms and termites and other invertebrates that live in the soil and they are a sign of rich fertile soils. On this basis tree nursery training was conducted as from 24th-29th August 2009 at Mwalangi Hall and Practicals were conducted in Mrongo Nyota Nursery. Five representatives from each of the five tree nursery groups were trained.

TRAINING

- **Objectives**

1. To emphasize on importance of environmental conservation
2. To Impact skills on establishment and management of tree nurseries
3. To Impact skills on how to restore the lost vegetation cover

The following topics were covered in the training.

- **Course Outline**
    1. Introduction
    2. Seed identification, collection and handling
    3. Types of nurseries and factors to consider on site selection
    4. Seedbed preparation/tools used
    5. Viability testing (afloatation test)
    6. Scarification
    7. Sowing of seeds in seed bed
    8. Shade construction/mulching, watering
    9. Management in Nursery-weeding
    10. Thinning, pests and disease scouting
    11. Polybag sizes in relation to seedling type
    12. Media types and ratios and treatments
    13. Potting
    14. Hardening off
    15. Seedbed preparation practicals
    16. Pricking out
    17. Nursery Plan and Layout
    18. Arranging seedling in the Nursery
    19. Management in the Nursery
    20. Record Keeping
    21. Sowing of seeds in seedbed practicals
    22. Tree propagation
    23. Pest and disease scouting and control
    24. Marketing
    25. Transplanting procedure
    26. Management in the field
    27. Plan of Action

At the end of the training the following plan of action was agreed

Week 1: Seed collection and storage
Week 2: Seedbed preparation and Sowing of seeds
Week 3: Sourcing of river sand, manure, and potting
Week 4: Attending the seedbed
Week 5: Pricking out
Week6&7: Digging of planting holes in the forest
Week8&9: Planting of the seedlings in the forest

NB: Monitoring or Back stopping will take place four times in a month.

- **EDGE Fellowship**

Dorine Ngeti attended the EDGE Fellows Training course in Zoological Society of London (10-23 August 2009).

Issues covered include;

- Prioritizing conservation effort (species to ecosystems)
- Conservation of threatened species
- Population Habitat Viability Analysis
- Instruments
- Introduction to field method Line transects & practical
- Analyzing data
- Data analysis – GIS
- Communication, Education and Public Awareness (CEPA)
- Project planning & management
- Strategic planning process – developing EDGE species status review

CHALLENGES

The major challenge facing the productivity of these tree nurseries is inadequate water to raise the seedlings. Provision of water storage tanks will be an option to improve the situation on the ground that needs to be explored.

CONCLUSION

Caecilians are currently living within indigenous forest and will be able to expand into newly replanted areas, thereby expanding their range. Once this species has a permanent and undisturbed reserve it will be possible to make a reassessment of its IUCN threat status. We expect that field studies at this time will indicate movement from Critically Endangered to Vulnerable or even non Threatened Status.

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APPENDIX

1. PHOTOGRAPHS OF ACTIVITIES

BARAZA/PUBLIC MEETINGS

FAMILIARIZATION TOUR

GROUP NURSERY WITH SEEDLINGS

DRAINED WETLAND (MWAJIKA)

CULTIVATED WETLAND

NURSERY TRAINING: FIELDWORK

NURSERY TRAINING: CLASSROOM WORK

2. DETAILED BREAKDOWN OF BUDGETS

i. BUDGET – ASU

Description	Quantity	Units	Proportion	Amount (US$)
1. Salaries				
EDGE Fellow (Project Officer)	12	months	100	12,063.64
Sub - total				12,063.64
Administrative Cost				
ZSL administrative cost (5%)			0.05	603.182
TTWF administrative cost (5%)			0.05	603.182
Sub - total				1,206.36
14. TOTAL				**13,270.00**

ii. BUDGET – CI/CEPF Amphibian Conservation Action Fund

Description	Quantity	Units	Proportion	Amount (US$)
2. Training of Planning Team				
Transport (Wundanyi-Voi)	100	km	2	250.00
Per diem - 2 EAWLS	2	persons	1	100.00
Per diem - GoK team members	4	persons	1	170.00
Per diem - Community reps	9	persons	1	180.00
Per diem - Prov. Admin.	4	persons	1	80.00
Venue hire and snacks	1	days	1	50.00
Stationary/training materials	3	set	1	100.00
Trainer - FD HQ PFM In-charge	3	days	1	148.43
Facilitation Fee	1	days	2	65.97
Sub - total				1,144.40
3. Awareness Creation				
Transport	200	km	5	1,121.49
Lunch allowances team members - EAWLS	1	persons	5	60.00
Lunch allowances team members - GoK	2	persons	3	50.00
Lunch allowances community reps	1	persons	4	20.00
Lunch allowances - Prov. Admin	3	persons	3	30.00
Sub - total				1,281.49
4. Forest Associations Formation				
Application fee	3	fee	1	123.69

Bankers cheque charges	3	charges	1	24.74
Sagalla Constitution drafting - comm	2	days	3	19.79
Sagalla Constitution drafting - Prov. Admin.	2	days	1	8.25
Constitution drafting - Team/EAWLS	6	days	2	142.50
Constitution drafting/FD	6	days	2	98.96
Transport	187	km	6	1,258.32
Sub - total				1,676.25
5. Stakeholder analysis				
Transport	200	km	3	672.90
Lunch allowances team members - EAWLS	1	persons	3	40.00
Lunch allowances team members - GoK	4	persons	3	100.00
Lunch allowances - community reps	9	persons	1	30.00
Lunch allowances - Prov. Admin	4	persons	1	20.00
Sub - total				862.90
6. Visioning workshop (Vision, mission & objective setting)				
Transport	200	km	1	224.30
Mwangi Githiru - NMK	1	persons	1	144.31

Lunch allowances team members - EAWLS	1	persons	5	20.00
Lunch allowances team members - GoK	4	persons	1	50.00
Lunch allowances - community reps	9	persons	1	30.00
Lunch allowances - Prov. Admin	4	persons	1	20.00
Sub - total				488.61
7. Resource inventory & data collection				
Transport	200	km	3	672.90
Per diem - EAWLS	1	persons	3	148.43
Per diem - GoK	4	persons	3	500.00
Lunch allowances - community reps	9	persons	3	100.00
Lunch allowances - Prov. Admin	4	persons	0	-
Sub - total				1,421.33
8. Identification of thematic areas				
Transport	200	km	3	672.90
Lunch allowances team members - EAWLS	1	persons	3	30.00
Lunch allowances team members - GoK	4	persons	3	100.00
Lunch allowances - community reps	9	persons	3	90.00
Lunch allowances - Prov. Admin	4	persons	3	40.00
Sub - total				932.90
9. Preparation of thematic papers				
Allowances for thematic paper writing	10	papers	1	164.83
Printing expenses	10	papers	15	

				40.00
Sub - total				204.83
10. Data analysis, collation and drafting of plan				
Per diem - EAWLS	2	persons	5	250.00
Per diem - GoK	4	persons	5	85.00
Per diem - Community reps	2	persons	5	200.00
Mwangi Githiru - NMK	1	persons	10	145.00
Stationery	2	ream	1	50.00
Sub - total				730.00
11. Production & circulation of copies				
Stationery	10	copies	1	124.00
Circulation	200	km	1	224.20
Sub - total				348.20
12. Sub Total				**9,090.91**
Administrative Cost				
ZSL administrative cost (5%)			0.05	454.55
TTWF administrative cost (5%)			0.05	454.55
Sub - total				909.09
14. TOTAL				**10,000.00**

N.B. GoK = Government of Kenya; EAWLS = East African Wildlife Society

iii. ***Follow-up budget: Next stage of project (Funding requested from other sources)***

Description	Quantity	Units	Proportion	Unit Cost (KShs)	Amount (KShs)	Amount (US$)	Funding source (potential or approached)
Assessment of soil erosion							
Transport (UoH, Fi)	1	persons	1		96,000.00	1,570.72	WorldVision
Per diem	90	days	1		288,000.00	4,712.16	
Sub - total					384,000.00	6,282.88	
Presentation to FD Headquarters							
Transport - Nrb	1	trip	1	2,500	2,500.00	41.23	EDGE public donations
Allowances - DFO	4	days	1	3,000	12,000.00	197.91	
Allowances - PC	4	days	1	3,000	12,000.00	197.91	
Sub - total					26,500.00	437.05	
Tree Seedlings Production and Planting*							
Nursery equipment & supplies					135,650.00	2,237.22	WorldVision
Training on nursery					53,900.00	888.95	
Nursery labour					936,000.00	15,437.04	
Planting					883,400.00	14,569.53	
Sub - total					2,008,950.00	33,132.73	

3. ABOUT THE APPLICANTS

John Measey is an amphibian biologist specialising in the ecology of caecilians for nearly 10 years. Author of over 50 scientific articles, British born John has worked in East Africa since 2002 and has experienced working in Africa for over 20 years. He is based in Cape Town, South Africa, where he works for the South African National Biodiversity Institute as a researcher on threatened species. John's experience in East Africa has convinced him of the need for local solutions to local problems and this is the principle that lies behind his approach to conservation work in the region.

James Mwang'ombe heads East African Wild Life Society in the Taita-Taveta region. James is a forester by training and has immense respect in the Taita area for his successful ongoing projects replanting government plantations with indigenous forests, and sustainable income from natural forests including butterfly farming and bee keeping. He lives in Wundanyi in the Taita Hills with his wife and family, and works at offices in Wundanyi and nearby Voi. James has many years of hands on conservation experience within the Taita Hills and his involvement is pivotal to the success of this project.

Mwangi Githiru is an ornithologist and conservation biologist based as the National Museums of Kenya, Nairobi. Mwangi studied the birds of the Taita Hills first through a prestigious Rhodes scholarship at Oxford University and then as a Marie-Curie Fellow in Antwerp, Belgium. He now lives in Nairobi but travels frequently to Taita to supervise local field assistants and continue his campaign to safeguard the forests in the region as well as conversion of government plantations into indigenous forests.

Petri Pellikka is a professor of geoinformatics at the University of Helsinki specializing in environmental remote sensing for the last 20 years. His current research activities are focusing on forest and land use change in the Taita Hills. He is an author of more than 100 scientific and popular articles, and has supervised more than 20 MSc thesis (7 dealing with land use in Kenya) and 4 PhD thesis dealing with remote sensing. He did his own MSc thesis about land use in the Taita Hills in 1990 and continued his Taita studies in 2003. Petri carried out his PhD studies at the University of Munich 1992-1995 and post-doctorate studies at Carleton University, Canada 1998-1999. He has also worked in the Sudan and is currently visiting scientist at the University of Cambridge.

Helen Meredith is the EDGE Amphibian Coordinator at the Zoological Society of London and has been involved in the development of this project since its inception. She has carried out extensive research into the status, threats and conservation requirements of EDGE Amphibian species, and is responsible for the design, implementation and coordination of all EDGE Amphibian conservation projects. She has a Masters degree in Biodiversity, Conservation and Management from Oxford University, and has studied environmental science and conservation at Harvard University. She has organised field expeditions to locations such as Haiti, French Guiana and Indonesia, and has been a member of numerous additional field project teams. She is an experienced field herpetologist who has participated in several amphibian conservation projects worldwide, including population surveys, screening for chytrid fungus, and field collection of wild amphibians for captive breeding programmes. She will be presenting the EDGE Amphibians project at the 6th World Congress of Herpetology in August 2008.

Dorine Mkaluma Ngeti will be appointed as the project officer and EDGE Fellow. She is keen local environmentalist with a B.Sc. in Environmental Science from Egerton University and much practical experience in conservation with organizations such as the East Africa Wild Life Society and WorldVison. Her CV follows.

CV: Project Officer and EDGE Fellow

PERSONAL DETAILS

NAME: **DORINE MKALUMA NGETI**
DATE OF BIRTH: **22ND MAY 1984**
MARITAL STATUS: **SINGLE**
NATIONALITY: **KENYAN**
SEX: **FEMALE**
PROFFESION: **TO BECOME A LEAD CONSERVATIONIST.**
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EDUCATIONAL BACKGROUND

DATES ATTENDED	INSTITUTION	EDUCATION and GRADES
2003-2007	**Egerton University,** P.O Box 536, Njoro.	**B.Sc (Environmental Science)** Second Class Upper Division
1998- 2001	**Murray Girls High School** P.O.Box 1069 Wundanyi.	**KCSE Exams** **Passed: B (Plain)**
1990-1997	**Sungululu Primary School** P.O.Box 1001, Wundanyi.	**KCPE Exams** **Passed: 488 Marks**

PROFESSIONAL AND WORK EXPERIENCE

Date	Designation	Accomplishments
JUNE 2008 to date	**EIA/EA consultant** Ecoplan Limited	Worked as an Environmental Impact Assessor/ Environmental Auditor where Major activities include report writing for Various development projects.
JAN- FEB 2006	**Project Assistant** East Africa Wild Life Society Wundanyi	Worked with project co-coordinator in Forest Health monitoring, forest connectivity project in Taita hills, Butterfly rearing project, Integrated Vegetable Pest Management.
Aug- Dec 2004	**Office Assistant** WorldVision relief department Voi	Staffing issues, asset and stationery Management, General office operations, Aiding Commodity Tracking System officers, and food monitors.

OTHER SKILLS ACQUIRED

Dates	Place	Skill
2007	Egerton University Engineering Department (PASA)	**Certificate in Statistical analysis of data.** Statistical Package for Social Sciences (SPSS).
2003	Global Education Partnership	**Entrepreneurship and Employment Programme** Studied MS–Dos, Web Design, Software and Hardware Engineering and programming in Basic

2002	Ekklessia Computer Training Centre	**Certificate in Computer Applications** Introduction to MS-DOS and WINDOWS MS Word, MS-Excel MS-Access, MS-PowerPoint.

EXTRA-CURRICULUM ACTIVITIES

Dates	Place	Achievements
31st Aug-1st Sept 2007	**Research Assistant** East African Wild Life Society	Worked in collaboration with Sokoine University in Tanzania to collect data on *Prunus africana* in Taita.
2003-2007	**Active Member** Youth Wildlife Environmental Movement Egerton University	Conservational Activities around campus were centre core of its Mission clean –ups and Animal count in L.Nakuru, participation in world environmental days every 5th June where global issues affecting the Environment was addressed.
2005-2007	**Christian Union**	Served as Christian Union Vice Secretary and Secretary of Uttermost Evangelistic Team.
1999-2001	**Wildlife Club** Murray Girls High School	Club Secretary, Maths Club Treasurer School Prefect

HOBBIES

- Playing outdoor games especially netball and basketball
- Reading especially Environmental Journals and Inspirational books
- Watching educational movies and documentaries
- Listening to gospel music

PERTINENT INFORMATION

Career: To become a lead conservationist
Availability: Immediately
Salary: Negotiable

REFEREES

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