

SAVE Lesson 1: Introduction Kakamega Forest and Conservation **(Time 2 hrs)**

A. What is SAVE (10 min)

“Swift Advocacy for Viable Environments.”

We have a mission to educate and promote interest in conserving Kakamega Forest. We started visiting local schools to do this two years ago.

Who are we individually ...

B. What is our lesson plan with this school (10 min)

Series of three lessons:

- 1) Introduce Kakamega Forest and Conservation (Today)
- 2) Ecosystem Dynamics and Conservation
- 3) Sustainable Alternatives

We are here to encourage interest in the forest and its biodiversity, so at the end of our lesson series we will invite a select few students to visit KF to learn more about it and the research that is conducted in it. All expenses paid. We will select you based on your performance in two short essays – one you will write today and one during our last session.

C. Essay/Assessment (20 min, 5 for prompt and preparation, 15 for essay)

Essay topic: ...

Each student should write all of his or her names and her year in school.

D. What is Kakamega Forest: (20 min)

Natural history

- KF is the easternmost fragment of the rainforest that once, thousands of years ago stretched from Guinea in West Africa, across the Congo rain forest, into Kenya. We know this because the vegetation and animals in Kakamega forest are most similar to forests seen in Western and Central Africa.
- KF is actually a mosaic of forest and natural grasslands.
- Current size of Kakamega Forest (not including smaller fragments of Malava, Kisere, & Bunyala) is approximately 240 km². For perspective, Kakamega county itself is 3,034 km². That means that KF makes up only 0.08% of Kakamega county. It is a small forest.

Reduction to current size

- One hundred years ago the forest extended to the west approximately 20 km and was continuous to the south with the Nandi forest. Humans (both local Kenyans and Europeans) logged the forest extensively for timber, reducing the forest to its current size.

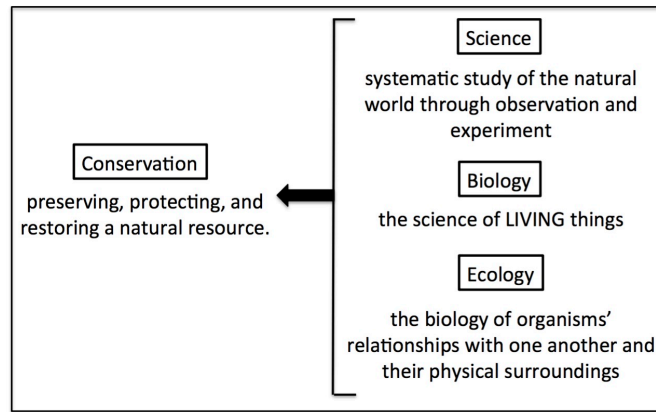
Management

- Today the forest is managed by two agencies in Kenya (use map).
Northern portion is the *Kakamega National Reserve* and managed by Kenya Wildlife Service.
Southern and larger portion is the *Kakamega Forest Reserve* and managed by Kenya Forest Service.

E. What is Conservation? And what is Conservation Science? (10 min)

(Draw definitions in diagram on board starting with Conservation)

We can use the science of biology, and its subfield of ecology, to help us understand how to conserve natural resources. Take notes on and remember these definitions, because we'll talk more about how ecology is relevant to conservation in Lesson 2.



H. Break/Game

G. Amazing biodiversity to conserve in Kakamega Forest (40 min: 5 min intro, 6 min per section)

There is a great diversity of wildlife in Kenya, but Kakamega Forest is in itself a special “biodiversity hotspot.” That means there are many many species of plants and animals in KF. KF is a particular hotspot for *birds, butterflies, dragonflies, ants, and snakes*.

Of all of these species of animals found in Kenya, 50% are found in Kakamega Forest. So for example, there are 1065 bird species recorded to live in Kenya. 488 of those birds are found in KF. Of the 900 species of butterflies found in Kenya, 487 are found in KF. And so on.

Trees

- We can divide tree types in the forest into *indigenous* and *exotic*. Indigenous means that the trees have originated, or evolved, in Kakamega and its ancestral rainforest. Exotic means that the tree was introduced from a different place. Indigenous trees that are very characteristic of the old forest are *Olea capensis*, *Prunus africana*, *Diospyros abyssinica* – all slow-growing species. Because of logging, these slow-growing species have been replaced in many areas by fast-growing indigenous species such as *Funtumia africana*, *Antiaris toxicaria*, *Croton megalocarpus*. Exotic species introduced to the forest within the last century are all fast growing and almost all were introduced to meet our need for timber. They include *Cupressus lusitanica*, *Grevillea robusta*, *Pinus patula*, *Maesopsis eminii*, *Eucalyptus spp.*, *Bischoffia javanica* and *Psidium guajava*.

Birds

- KF is internationally designated as an important bird area or IBA. 488 species of bird recorded in KF (46 found only in Kakamega). **Black and white casqued hornbill, great blue turaco, ross’s turaco, akalat** (or other insect predator), roller, malachite kingfisher.

Reptiles and amphibians

- 36 snake and 21 lizard species in KF. Boulenger’s **pygmy chameleon** (only one of two found in Kenya), forest dwarf gecko, Philip’s sand snake, Gold’s tree cobra, **gaboon and rhinoceros vipers**, Jameson’s mamba; 24 frog species, Kakamega forest tree frog. Some snakes are venomous some are not. The one that you commonly find at your and my homes is NOT venomous.

Mammals

- What is a mammal? A mammal has mammary glands, live birth not eggs, hair and fur, 4 chambered heart. This is the group of animals that includes you and me. Elephants, buffalos, and hyaenas once inhabited KF (hunted to local extinction); today, three species of **duikers**, primates (monkeys: **blue, redtail, black and white colobus, de brazza’s, pottos**), forest rat, **pangolin**, palm civet, genet.

Insects

- What is an insect? An insect is an arthropod with 3 pairs of legs. Ants (200-250 species, more species in this one area than any other place in Kenya), 25 species of termites (62 in Kenya). What is the difference between an ant and a termite? Butterflies (487 species), dragonflies (72 species – 42% of all Kenyan species), 243 species of bees, 1,023 species of beetles 9(!).

H. Closing & Questions from students (10 min)

SAVE Lesson 2: Ecosystem dynamics and Conservation
(Time 2 hrs 20 min)

A. Reminder: (15 min)

What is SAVE.

Who we are individually...

Where we are in the series:

- 1) Introduce Kakamega Forest (Flora and Fauna) and Conservation
- 2) Ecosystem dynamics and Conservation (Today)
- 3) Sustainable Alternatives

B. Start-up game – hornbill and cup (10 min)

C. Review and introduce ecology definitions (10 min)

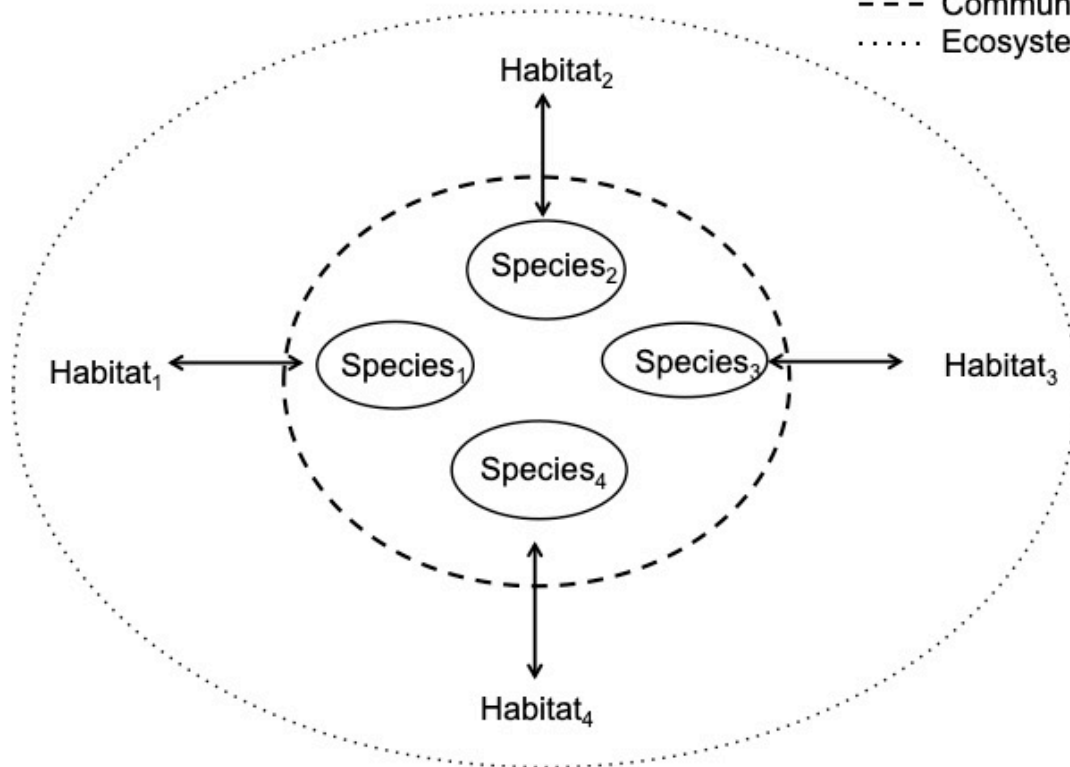
Review terms: Conservation, Ecology (1 min)

Introduce terms (use diagram, ask students to contribute definitions, should be review for Form 3-4 Secondary school so should not take too much time):

- Species – a number of organisms that resemble one another physically and genetically and can produce viable offspring (i.e. offspring that can produce more offspring).
- Habitat – the physical environment where an organism lives.
- Population - the number of individuals of a given species in an area.
- Ecological role – how an organism interacts with its habitat, and thereby changes the nature of its habitat (an organism’s ecological “niche” is the sum of its eco-roles).
- Community – the number and kind of species living together in an area
- Ecosystem – a community of organisms and their habitats together

Organization of an ecosystem

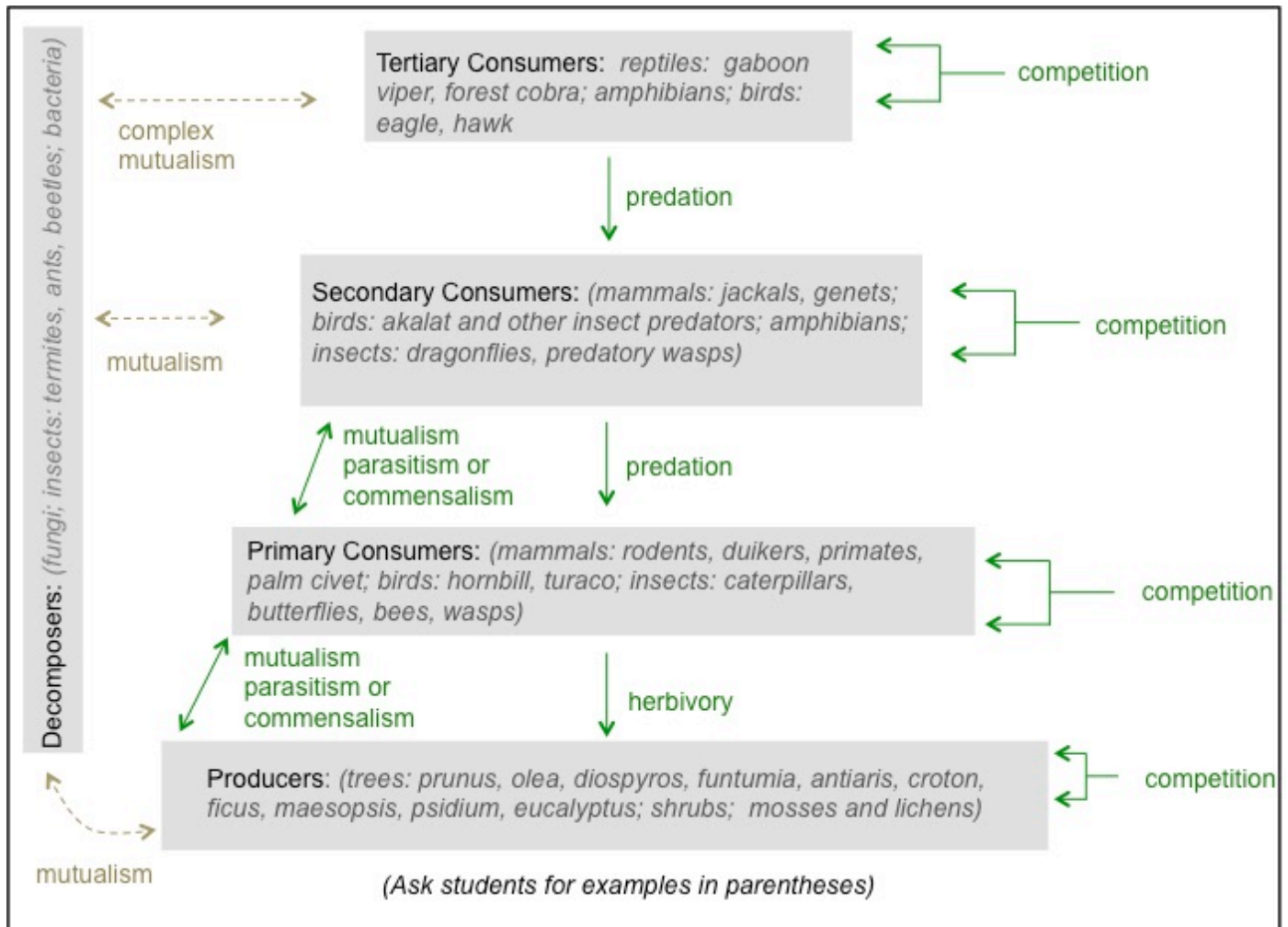
↔ Ecological Role
— Population
- - - Community
..... Ecosystem



B. Ecological roles: (20 min, 5 for intro and 5 per role)

I am going to draw organisms' broad ecological-roles in a food or energy pyramid. The category representing the largest amount of energy is at the bottom of the pyramid, and the energy reduces as the categories become smaller at each ascending level of the pyramid.

(To draw diagram, first draw boxes and begin to label and fill in with roles and species. Arrows and words in green should be drawn during section C.)



Producers (5 min)

- What is a producer? They produce their own food by converting energy from the sun into living matter. What are examples of producers in KF? (*Students contribute*). Broadly, they are plants – trees, shrubs, lianas, mosses, lichens. Producers provide food (leaves, fruit, seeds) and shelter for many other organisms in the food web. *Alive and dead*, producers hold soil and prevent its erosion, metabolize CO₂ and produce O₂, and store water in their vascular bodies and in the soil.

Consumers (5 min)

- What is a consumer? Simply put, they cannot produce their own food. They come in different types depending on what they eat – if they eat producers they are primary consumers. If they eat primary consumers, they are secondary consumers. The web goes up to tertiary consumers. What do tertiary consumers eat? What are examples of these different kinds of consumers in KF? (*Students contribute*).

Decomposers (5 min)

- What are decomposers? These organisms break down and decompose rotten material (from producers and consumers). Their presence has an enormous impact on nutrient cycling and the composition of soils. Because of this service, they are in a complex mutualism with all organisms in the ecosystem. What are examples of decomposers in KF? (*Students contribute*). Fun fact to remember: Kakamega forest has approx. 250 ant species and 25 species of termite.

Now that we have defined the positions of organisms in a food pyramid, we can describe how each relates and interacts with other organisms in the pyramid. (transition to following presenter)

C. Ecological interactions/relationships between organisms (20 min, 10 for each relationship type)

(Add green portions of example diagram to diagram on classroom drawing board. If possible use a different color of marker or chalk to write relationships.)

There are two main categories of ecological relationships are symbiotic and oppositional.

Symbiotic relationships – (10 min)

these are relationships where two organisms live in close association with one another.

- Mutualism – interaction between organisms that benefits them both.
 - E.g. fruit-eating birds use trees for food and shelter, and trees “use” fruit-eating birds for seed dispersal.
 - E.g. bees use flowers food, and flowers “use” bees to mix pollen from different plants of their species, so that they can be fertilized and form viable seeds.
- Parasitism – interaction where one organism takes nutrients directly from its “host” organism. The host pays a cost but usually does not die (e.g. tapeworms feed on humans and make them sick)
- Commensalism – interaction that benefits one organism but does no harm to the other (e.g. birds use trees to nest, the bird benefits but the tree does not suffer).

Oppositional relationships – (10 min)

these are slightly different from symbioses, because either one or both organisms in the interaction are harmed more greatly than in any symbiosis.

- Predation/Herbivory – interaction where a consumer eats (and kills) another consumer (predation, e.g. birds kill and eat mice) or producer (herbivory, e.g. goats eat and kill grass).
- Competition – interaction between organisms where the lives of each depend on a shared but limited resource. Both are harmed because both receive fewer resources while in interaction than when alone.

C. Blue monkey scramble activity (45 min)

We’re going to play a game now that focuses on one kind of relationship between species in a community: competition.

D. How ecological relationships relate to conservation: (10 min)

Species can indicate the quality of their habitat because of their links within the food pyramid and their ecological relationships. For this reason we call them “indicator” species. For example:

- As per our activity – the size of the monkey population *indicates* how many resources are available, or the quality of its habitat, and the strength of the monkeys’ relationships with other organisms.
- The Akalat: the ant species that the Akalat follows cannot thrive in forest fragments below a certain size. When forests become smaller, the ant population declines, and the presence of Akalat’s declines from 50 to 100% (Mitchell 2009). The presence of the Akalat *indicates* that area of the forest where it is found is not overly fragmented.
- Dragonflies: dragonflies are secondary consumers in food pyramids, so their presence *indicates* that the species that they eat and the food of the species that they eat are present. (Mitchell 2009)

E. Closing and questions from students (10 min)

SAVE Lesson 3: Becoming a conservationist

(Time 2 hrs 20 min)

A. Introduction (5 min)

Briefly re-introduce SAVE members.

Give roadmap: lesson 1 was an introduction to Kakamega Forest, lesson 2 was an introduction to ecosystem dynamics, and today we are talking about the worth of a healthy forest and what strategies we can use to keep the forest healthy.

B. Review (5 min)

Definitions of “Ecology” and “Conservation”

Review conservation status Kakamega Forest from Lesson 1 (how the forest has grown smaller in the past 100 years, how species are being lost because of human pressure)

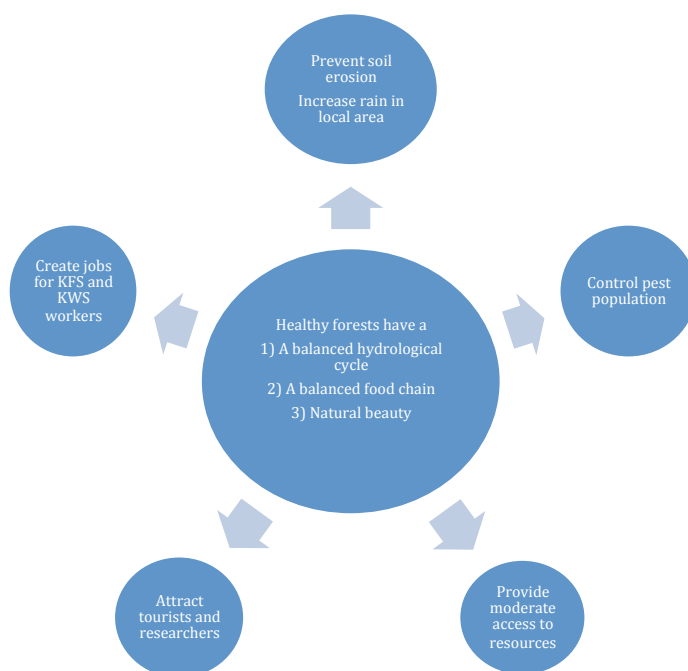
C. Worth of a healthy forest: (30 min)

A healthy forest has

- A healthy hydrological cycle, natural water catchment
- A balanced food chain
- Natural beauty

These characteristics of a healthy forest

- Prevent soil erosion and increase rain in its local area
- Control the pest population (rodents and insects)
- Attract tourists that generate income to local area (need tour guides, homestays, food, souvenirs)
- Provide a natural laboratory for researchers, which generate income to local area (need assistants, housing, food)
- Create jobs for Kenya Forest Service and Kenya Wildlife Service staff (officers, researchers, and askari)
- Finally, a healthy forest provides regular but moderate access to forest resources (Ask students what they think these resources are and list in diagram)
 - timber, firewood, grass for thatching, lianas for tightening grass and rails
 - medicines (about 95% of indigenous trees are medicinal),
 - Grass and water for some livestock
 - Bushmeat (this, however, is always illegal)



What is legal and illegal resource use? (10 min)

- **Legal** in KFS Nature Reserve: watering and grazing cattle, grass harvesting; collection of medicinal herbs, honey, firewood for domestic use (not for sale), creepers/lianas for construction.
- **Illegal** in KFS Nature Reserve: firewood for charcoal, hunting bushmeat.
- **Illegal** in KWS National Reserve: all above activities.

D. Activity (10 min)

Share KWS flipbooks or other activity

E. Intro to pressures and alternatives: (10 min)

Extracting resources from the forest creates pressure on the forest, because it challenges the forest ecosystem to remain in balance. Some pressure the forest can recover from, but *over-extraction* creates pressure so strong that the health of the forest is degraded.

Examples

- Removing dead wood. In our energy pyramid, a large portion of organisms (bacteria, insects, fungi) were decomposers, that is, the organisms that recycle nutrients from dead things back into the forest. So even taking dead wood from the forest removes the food of the decomposers and the nutrients available to return to the living forest. Taking too much dead wood deprives the forest of critical nutrients.
- Grazing animals. Animals trample trails while feeding or on their way to fields and water points. This destroys young plants and soil in the forest. Trampling too many of these seedlings changes the structure of the forest so that these areas have only old, large trees, and undergrowth that is thick with weeds. In time, there will be no young trees to replace the older trees.

What we are going to present as “alternatives” are things that help take pressure off the forest and prevent *over-extraction* while allowing humans to meet their needs.

F. Alternatives (60 min, 15 per topic)

Planting a tree nursery, creating beehives, animal husbandry, energy-saving methods for cooking.

1) Planting a nursery is a solution for acquiring

- Firewood
- Wood for construction
- Medicines
- Herbs
- Fruits
- Income

Basic steps to start a tree nursery

- Sites for starting a nursery are not difficult to find. You need an open area that receives lots of sunlight and has good water drainage (i.e. not at the bottom of a pit, not at the top of a hill).
- What to plant
For firewood and construction:
 - * *Eucalyptus spp.* – exotic, fast-growing
 - * *Grevelea robusta* – exotic, fast-growing, able to plant on same plot as maize and other crops
 - * *Cupressus lusitunica* – exotic, moderately fast-growingFor medicines:
 - * *Croton macrostachus* – indigenous, tree, medicine for stomach ache
 - * *Olea capensis* – indigenous, tree medicine for congestion
 - * *Trichilia ametica* – indigenous, tree, medicine for stomach ache and head ache
 - * *Osmum kilimandischarica* (Myunyi) – indigenous, shrub, medicine for insect bites and congestion
 - * *Mondia whitei* (Mkombelo) – indigenous, climber, medicine for stimulating lactationFor fruits: ready in five years
 - * *Mangifera indica* – exotic, mango
 - * *Persea americana* - exotic, avocado

* *Psidium guajava* – exotic, guava

For other products:

* Sisal – indigenous, shrub, used to make baskets

- To start your nursery you can buy viable seeds from KEFRI or buy available seedlings from the Isecheno tree nursery. You can also consult the Kenya Agriculture Research Institute in Kakamega Town for more advice on starting a nursery.

2) Creating bee hives (or apiaries) as a solution for acquiring

- Honey
- Income

Basic steps for how to create a beehive

- Identify an apiary site. The best will be close to a source of water and flowering plants, and will have natural (or manmade) shade to keep hive from overheating. The area should be fenced in to protect people and animals from being stung.
- Find a local carpenter with knowledge of how to build a hive (can be about 3,500 KES, including timber and construction). Or you can purchase a ready-made beehive from Honey Care, Africa Beekeepers Company at 5,000 KES. Finding a carpenter with such knowledge is not difficult; there are two beehive building carpenters in Shinyalu, one in Shibuye, and one in Virhembe, for example.
- Build a stand for the beehive so that the hive is at breast height while harvesting honey. Plan the spacing of the beehives if you have more than one.
- When the hive and stands are ready then paint the inside with honeycomb to attract bees. Can also place a tray of sugary water near hives to attract bees. Paint the outside of the hive with a bright color, like flower, mimicking a flower. The outside color also attracts the bees.
- One beehive will produce 20 L of honey after three months. You can harvest honey 3 times a year from one hive. At a local market you can sell your honey at 650 shillings per liter. Overall that's 20 L x 3 times per year x 650 shillings = 3,900 shillings for one hive per year. As you can see, you will start to make a good profit on the hive after the first year.

3) Animal husbandry is a solution for

- Meat
- Income

Basic steps for how to start raising animals for consumption:

Poultry farming

- This farming is cheap to start. One chick is about 100 shillings. Good to buy the chickens as chicks so you know their developmental history. Good to get both males and females so that you can yourself produce chicks. The cockerels will fertilize the hens' eggs and are themselves a good source of meat. White leghorns are good egg-layers can give one egg per day for about three weeks, they then recuperates for about 2 weeks before continuing to lay. If you allow the hen to hatch her fertilized eggs, it takes three weeks for the eggs to hatch and 3 months to raise the chicks, after that time the hen will start to lay eggs again.
- To house the chicks make a coop (a closed house) inside a meshed wire area. The chickens will sleep inside the coop and sun themselves and eat outside the coop within the mesh.
- You can feed the chickens special chick mush (for young ones), broiler mush (for meat hens), or even leftover ugali.
- You can sell chickens from 600-1200 shillings, depending on the time of the year and whether you have a hen or a cock (cock's cost more).
- More information can be sourced from the Agriculture and Livestock office in Shinyalu.

Rabbit farming

- You can purchase young rabbits locally, usually for about 200 shillings.
- To house them build a hutch close to your house to hinder thieves. A hutch is best made with mesh wire as flooring (for feces and urine to exit) and with a separate wooden room (like the chicken coop) for sleeping and shelter. Use iron sheets for a shade. Keep males housed separately from females at all times other than mating so that males do not eat the newborn rabbits.
- Feed rabbits any local greenery or leftover greens from cooking (e.g. cabbage, old carrots).

- You can sell adult rabbits at 400 shillings each.

4) Alternatives in the kitchen:

All of the following alternatives will save you time from going into the forest to collect more firewood and help the forest to remain in balance.

a) Upesi jiko instead of three-stone jiko.

Upesi jiko (also known as Maendeleo Jiko, Jiko Poa, Kuni Tatu/Mbili Jiko, Jiko Kisasa) is an improved ceramic stove baked in a furnace and either installed permanently in a kitchen or fabricated using metal cladding to make a portable stove. Other examples of improved stoves include:

- Mud stoves
- KCJ (Kenya Ceramic Jiko) that uses charcoal
- Rocket stove

The ceramic liners help to conserve heat while directing heat directly to the pot hence less fire wood is used when cooking. It is estimated that one can save between 30 – 60 percent of fuel wood depending on the type of food being cooked.

Advantages of using improved stove:

- Safe to use
- Use less fuel wood
- Healthy – less smoke (reduced indoor pollution)
- Saves time and money
- Clean cooking environment

Where to purchase:

- Shinyalu and Khayega during market days
- Ilesi pottery groups at Ilesi, along Kisumu – Kakamega Highway
- During Agricultural Field Days
- ASK shows countrywide
- Kakamega Jua Kali sheds
- Price is usually about 200 for the jiko and 100 for installation

b) Briquettes instead of charcoal.

Briquettes are made from waste paper, saw dust, leaves and other waste material. They are compressed and can be used as substitute for charcoal. In some towns like Nairobi they are packaged well and sold in supermarkets

[Need to update for future: How/where to make briquettes?]

c) Food warming baskets instead of prolonged cooking.

Food warming baskets are also known as basket fireless cookers. Normal baskets are lugged with insulating materials such as blanket wastes, pieces of cloth materials from the tailor or you can use old clothes from your home that no longer fit or are torn. Food is precooked for some time (varies from one type of food to another). The partially cooked food is wrapped in a piece of cloth and carefully placed in a basket food warmer. The food will continue cooking until it is fully cooked. The time taken to fully cook food varies from one type of food to another.

Examples of cooking suggestions:

- Rice – boil the rice with all the ingredients (depending on your preference) for two minutes (bubbling for 2 minutes). Cover the pot (sufuria) with a tightly fitting lid and transfer to the food warmer. The rice will be ready for serving after 30 minutes and can keep warm for 8 hours if not interfered with.
- Beef – fry or boil the meat with required ingredients for 10 minutes. Cover the pot (sufuria) with a tightly fitting lid and transfer to the food warmer. The beef will be ready for serving after 2 hours and can keep warm for 8 hours if not interfered with.

- Githeri – boil the githeri for 30 minutes. Cover the pot (sufuria) with a tightly fitting lid and transfer to the food warmer. The githeri will be ready for serving after 3 hours and can keep warm for 8 hours if not interfered with.

G. Closing (10 min)

- We have been lucky to work with students like you. You are the future and the health of Kakamega Forest is in your hands.
- In our lesson series you have learned about three things
 - What is Kakamega Forest and what lives inside of it: trees, insects, reptiles, birds, and mammals. Even fungi and bacteria.
 - How those living things are related to each other and to humans.
 - How we can live in harmony with the forest, so that together we may prosper.
- Many of your essays about _____ were excellent. But we could only choose 14 outstanding students to join us for a trip to KF. We have communicated with your (relevant school authority) and he/she will speak to the selected students to invite them to the forest.
- Thanks to all.
- Closing prayer.

H. Speak to relevant authority at school to invite high performing students.

(Note, for future selection: The least capacity of matatu for hire is 14-seater.)

Optional future activity suggested by Evans:

1. Students to be arranged in the play ground with a ball.
2. Let them start passing the ball to each other.
3. Other group of students or teachers representing community members around the forest with different interest to be spread around the play ground.
4. The team that is around the play ground to be poaching individuals that are in the field one-by-one randomly
5. As the team around the play ground continues to poach “resources” from the “forest” the distance between the individuals increases hence difficult to pass the ball (“service”) and easy to be poached by the community. I:e a monkey moving from one tree to another that is 500m apart.

KEY:

Play ground = a healthy forest

Students in the field = Resources in the forest i:e trees, monkeys, birds, insects etc.

The people around the play ground = the communities that stay adjacent the forest with different interests from the forest.

A ball= the role different species play within an ecosystem