

Mangroves of Kenya

EXPEDITION BRIEFING

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Dear Volunteer,

Welcome to 'Mangroves of Kenya,' an exciting new Earthwatch project; we are delighted that you have chosen to join us. You will be helping to maintain and restore a vital ecosystem, as well as investigating some fundamental questions in ecology. And you will be doing this by working with the local community in a peaceful and picturesque Kenyan village.

My name is Mark Huxham, and I am the lead Principal Investigator on this project. My background is in marine and theoretical ecology. Like many other academic ecologists, I have become increasingly concerned about how we can use our science to answer real questions of major importance to people, especially those people who rely most directly on natural resources. This, combined with the fantastic opportunity to collaborate with people from Kenya and around the world in a fascinating environment, is why I am working on this project.

There will be two other Principal Investigators working with us. Dr. James Kairo has ten years of experience replanting mangroves in Kenya and around the world. As a resident of Gazi, our field site, James has pioneered community involvement in mangrove restoration there, and will make sure our work has the full co-operation and support of the village. Dr. Martin Skov studied for his Ph.D. on the Tanzanian island of Zanzibar, where he investigated the ecology and physiology of the crabs which form such an important part of the mangrove ecosystem. His expertise in these organisms, as well as his general experience working in mangroves, will prove invaluable in this project. As well as James and Martin, we will be joined by Alfred Obinga, our field assistant, and by other local and international colleagues interested in our work.

I hope the information contained in this briefing will answer any questions you might have about the project. If you need further information concerning the logistics and organization of the expedition, then please contact Earthwatch in the first instance. However, if you have questions regarding the science or anything else that Earthwatch cannot answer, feel free to contact me.

Best wishes, and I look forward to working with you.

Dr. Mark Huxham

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RESEARCH PROPOSAL

PRINCIPAL INVESTIGATOR: 1) Mark Huxham Ph.D.
2) James Gitundu Kairo, Ph.D.
3) Martin Wiggers Skov, Ph.D.

POSITION/TITLE: 1) Senior Lecturer
2) Principal Research Officer
3) Research Fellow

AFFILIATION: 1) Napier University, Edinburgh
2) Kenya Marine and Fisheries Research Institute
3) Port Erin Marine Laboratory, University of Liverpool

PROJECT TITLE: The effects of species richness on growth and ecosystem functions of restored East African Mangrove stands

RESEARCH SITE: Gazi Bay, Kwale District, Kenya

TEAM SIZE: Minimum: 6 Maximum: 14

Abstract of Proposal

Mangrove forests are unique ecosystems which provide a range of important goods and services. However, they are suffering high rates of destruction around the world, and will be one of the first ecosystems affected by the predicted sea level rise. This project aims to establish re-planted experimental plots of mangroves in cleared areas. Experimental treatments will consist of plots of three different tree species, along with all possible multi-species mixtures and unplanted controls. Volunteers will assist in planting mangroves, and in measuring a range of biological and physical parameters relevant to important ecosystem functions, such as productivity and growth rates, susceptibility to disease, faunal abundance (of fish and crabs) and sedimentary chemistry. In addition, single species stands will be planted in high wave impact areas to record the effects of trees on sediment dynamics (erosion/deposition).

RESEARCH PLAN

1. THE PROJECT

Human life depends on ecosystem goods and services, but the relationship between the number of species in an ecosystem and that ecosystem's ability to function normally is largely unknown. Given the loss of species in ecosystems around the world, the impact of reduced species diversity on ecosystem function is an issue of urgent importance. In the last decade, ecologists have been investigating the relationship between diversity and function using manipulative experiments in a range of habitats (see Tilman 2000). However, investigations in marine systems are rare (Emmerson and Huxham, 2002), and most experiments are conducted at very small scales, which can make interpreting the significance of their results difficult (Bolam *et al.*, 2002). We propose to conduct a long term, large scale experiment measuring a range of ecosystem functions in replanted mangrove stands. Previous experiments have been criticised for manipulating only a small fraction of the species naturally present at the experimental site, and for failing to distinguish 'genuine' species complementarity from sampling effects (Huston, 1997). Because there are relatively few species of mangrove in East Africa, we will be able to use all three tree species (*Rhizophora mucronata*, *Ceriops tagal* and *Avicennia marina*) growing sympatrically near our experimental site to create treatments containing all possible species combinations. This will allow us to overcome these problems. It has long been recognised that intercropping (mixing two or more species) in terrestrial agriculture can enhance productivity. Such effects may also occur in terrestrial forestry, and have been inferred (MacNae, 1968), but never tested, in mangroves. Our study will serve as an experimental test of intercropping in mangroves, thus addressing applied forestry questions as well as fundamental ecological ones. Mangroves themselves have one of the highest rates of degradation of any global habitat--exceeding 1% of mangrove area per year (Spalding *et al.*, 1997). Hence understanding their ecology and restoration is an international conservation priority.

One of the most important functions associated with mangroves is their ability to prevent or reduce coastal erosion (Wolanski and Ridd, 1986). However, most evidence supporting this idea is anecdotal or inferential. To our knowledge, there are no properly controlled experimental studies documenting the effects of mangroves on sediment dynamics, and how these effects might change and develop as a forest grows. Some areas where mangroves have been cleared or degraded in Gazi Bay show signs of enhanced coastal erosion (Abuodha and Kairo, 2001; Huxham, unpublished data). We propose to use these areas to directly measure the impact of restoring mangroves on coastal erosion and sedimentation.

The local people at Gazi are heavily dependent on the mangroves for direct economic uses, e.g., firewood and building poles (Kairo, 2001) as well as for ecological services, e.g., nursery provision for offshore fish. The extractive uses of the mangroves present a threat to their survival (Abuodha and Kairo, 2001), but also an opportunity for community involvement in their conservation. Previous community reforestation schemes at Gazi (led by one of the PIs) have proved successful (Kairo *et al.*, 2001). We intend to sustain the supply of mangrove goods and services by involving the local community in the replanting campaign.

2. RESEARCH OBJECTIVES

Our key objectives are to:

- Test how the diversity of mangrove species in replanted stands affects a range of ecosystem functions.
- Use controlled experiments to test the effects of replanted mangroves on sediment dynamics (in both low and high energy areas), and to measure how these effects change as the trees mature.
- Collect data of direct relevance to practical restoration projects (such as the role of intercropping in enhancing productivity and reducing disease), thus helping to inform future restoration efforts.
- Work with local people in establishing replanted mangrove plots, which will form part of a sustainably managed local resource.

We propose running the project for a minimum of five years (given the rapid growth rate of mangroves; this time scale will allow establishment of sufficiently tall mangrove stands). Our aims in each year are given below:

Field Season	Targets
1	Measuring baseline chemical, physical and biological data at the diversity treatment site (e.g., sediment temperature, nitrate, carbon, silt, redox; diversity and abundance of benthic macrofauna, including crabs, the most important macrofaunal group). Planting diversity treatments and controls. Establishing erosion stations. Helping with the collection of propagules/seedlings for growth in the nursery.
2	Recording, in re-planted and control treatments, the key chemical, physical and biological experimental variables (as season 1), plus rates of sediment erosion/deposition; growth and survival of seedlings, and evidence of insect attack. Measuring beach profiles at the erosion site (for control and treatment plots). Planting <i>Sonneratia</i> stands at the erosion site and establishing erosion stations there.
3	Measuring key experimental variables (listed above) at the diversity site. As the forests develop and biological communities assemble, we anticipate increasing heterogeneity and thus a requirement for greater numbers of sub-samples to provide representative results. In addition, more species and a higher abundance of crabs and other fauna will arrive. Thus, measuring these variables will require more work as the project progresses. Recording beach profiles (in control and treatment plots), erosion rates, growth and survival rates at the erosion site. Replacing lost/dead seedlings at the erosion site.
4	Measuring all experimental variables listed in season 2 for the diversity treatment, and season 3 for the erosion treatments. In addition, measuring fish and shrimp communities in the diversity treatments.
5	Measuring all variables described above, including fish/shrimp abundance and community structure in the diversity treatment.

3. METHODS

The project will involve replanting two separate denuded areas with mangroves; these areas and the methods applied to each are described separately below.

Area 1 (diversity experiment)

This is a low energy, muddy location with extensive areas of bare, clear-felled sediment. The effects of mangrove species diversity on ecosystem functions will be investigated by replanting an area of 33600 m² (8.3 acres). Combinations of one, two or three species of mangrove, from a species pool of *Rhizophora mucronata*, *Ceriops tagal* and *Avicennia marina*, will be planted. All these species occur naturally in mixed forests nearby. The plantation area will be subdivided into three experimental blocks, each 140 × 140 m (459 × 459 ft), separated from each other by 200 m (656 ft). Each block will be divided into nine 40 × 40 m (131 ft) plots, separated from each other by 10 m (33 ft) strips, and eight treatments will be randomly assigned to one plot per block. Hence our experiment will have a randomised block design with three replicate plots per treatment (Figure 1). Treatments will be all possible species compositions viz. 0 (controls), each single species, *R. mucronata* and *C. tagal*, *R. mucronata* and *A. marina*, *C. tagal* and *A. marina* and all three species. Planting density (1 per m²) will be the same for all treatments. Local field assistants will collect sufficient numbers of propagules of these three species in the four weeks before our arrival.

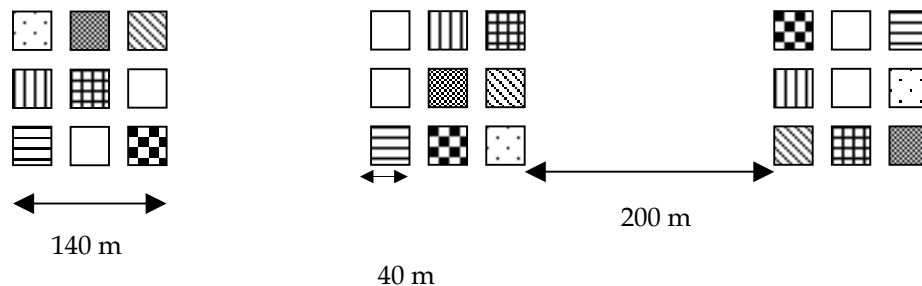


Figure 1. Diversity experiment design, showing proposed lay-out of the three experimental blocks. Each block contains a single replicate of each of seven planted treatments (represented by different shadings), one unplanted (ambient) control and one spare plot.

Area 2 (erosion experiment)

This is a high-energy beach, approximately 1 km (0.6 mi) long, with fragments of degraded wood and completely bare areas. Stands of *Sonneratia alba* (the only species adapted to these conditions) will be replanted here to measure the effects of mangroves on sedimentation and erosion. Three 50 × 50 m (164 × 164 ft) plots of *S. alba* will be planted adjacent to similar sized control plots of bare sand (the procedures for seed collection, transportation and installation are as described in Kairo, 1995).

Research Targets

Field Season 1

Area 1. The following variables will be measured before planting:

1. **Sediment redox.** This process measures the oxygen status of the sediment. Redox probes will be inserted to depths of 2 and 4 cm; readings will be recorded after 60 seconds of the probe being inserted or before if the reading has stabilised (Pearson and Stanley, 1979). A minimum of twenty locations (more depending on spatial variability) within the planting area will be sampled.
2. **Sediment carbon, silt and water content.** Forty 5 cm diameter sediment cores will be taken from random locations. Twenty will be analysed for water (weight loss at 60°C/140°F) and then carbon content (loss on ignition at 450°C/842°F, using a furnace in the Gazi laboratory); the other 20 for silt content (wet sieving to obtain fraction < 65 µm).
3. **Temperature** has been shown in previous studies to vary significantly between areas of mangroves with different tree density, and may affect sediment chemistry and biota. It will be measured to 1 cm depth at 20 random points.
4. **Sediment nutrients.** Twenty 10 cm diameter, 15 cm deep sediment cores will be taken at random locations. Pore water will be extracted using an adapted corer designed to compact the sediment in the field (previously used by MH). The water extracted will be sampled [using acid washed 100 ml bottles], transported to the laboratory in an ice-box and stored at 4°C (39°F). Nitrate, ammonium, phosphate and salinity will be measured in these samples using a Hach DR/2000 battery operated spectrophotometer and a refractometer. Previous work at Gazi has demonstrated levels of these nutrients detectable by this method.
5. **Crab diversity and abundance.** Binocular and burrow counting methods (Skov *et al.*, 2002) will be used to assess crab numbers in ten randomly chosen 0.25 m² quadrats. If necessary, these will be validated by excavation in one or two quadrats to ensure correct identification.
6. **Benthic macrofauna abundance and diversity.** Ten randomly placed 10 × 10 cm (3.9 in) box cores will be taken to a depth of 20 cm. The sediment will be preserved in 90% ethanol, stained with rose bengal, and sieved in the laboratory over a 1 mm (0.04 in) mesh to remove all macrofauna, which will be identified to at least genus level where possible.

After planting, four erosion stations will be established at random locations in each experimental plot. These will consist of two 2 m long, 5 cm diameter stakes, buried to 1 m depth 1.5 m apart. Sediment height at the midpoint between these stakes will be recorded, by measuring down from a horizontal cross bar.

Field Season 2

Area 1. Variables 1-6 (and sediment heights) will be recorded as described above (with a minimum of 2 sub-samples for each variable from each experimental plot), and three additional variables also recorded.

1. **Tree survival and recruitment.** 160 trees will be chosen using random (monospecific treatments) or stratified random (2 or 3 species treatments) selection in each plot. The proportion of these surviving will be recorded. Any naturally recruiting trees will be recorded in two 10 × 10 m random quadrats per plot.

2. **Tree growth.** Stem diameter (forest callipers) and height [using telescopic poles validated with absolute measures on edge trees once trees exceed 2 m] measured on the randomly selected sample.
3. **Insect attack.** Proportion of sample subject to attack by *Salagena discata*, a wood boring moth present at Gazi, recorded by visual inspection. Evidence of any other insect damage also recorded.

Area 2. Baseline profiles of all treatment and control plots will be recorded, using standard levelling poles, before planting. After planting, six erosion stations - as described above - will be placed randomly in each plot, and the sediment height recorded. Current speeds will be measured at six randomly chosen points in each plot using the gypsum dissolution method (Thompson and Glenn, 1994).

Field Season 3

Area 1. All variables listed for area 1 above will be measured (with greater replication if power analyses suggest this is necessary).

Area 2. Tree survival and growth will be measured, as described above. Previous work at Gazi found high mortality of trees in exposed areas (Kairo, unpublished data), hence we will need to replace dead seedlings. Beach profiles, current speeds and sediment accretion/erosion will be measured as described above.

Field Season 4

Area 1. All variables described above. In addition, fish/prawn use of replanted plots will be assessed using stake nets, 3 x 3 m long, 2 m high with 2 cm mesh (nets of this design have been used successfully at Gazi by MH). Eight nets will be deployed at low tide, one net per treatment plot in one of the blocks. The nets will be raised as near to simultaneously as possible at high tide by wading to the site, then emptied at the subsequent low tide. Two sampling sessions will be conducted in each of the blocks, giving 2 sub-samples taken from each replicate of each treatment. Fish and prawns will be preserved and identified to the species level where possible.

Area 2. All variables described in field season 3, above, and dead trees replaced.

Field Season 5

Area 1. All variables described in field season 4, above.

Area 2. All variables described in field season 3, above, and dead trees replaced.

4. APPLICATION OF RESULTS

Our project will benefit the following groups/institutions:

1. *Local level:* The degraded mangrove areas of Gazi will be rehabilitated using a participatory approach, thus enhancing mangrove goods and services for the community.
2. *National/regional level:* Our work will enhance national and regional capacity and skills relevant to future mangrove restoration efforts. For example, the work will enhance mangrove restoration

projects in Kenya, Tanzania and Mozambique where one of the PIs (JK) is a key advisor to mangrove projects.

3. *Global*: Scientific management of mangrove forests is a new idea, not only in the project area, but in most parts of the world. Our project will help answer some of the common questions about whether restored forests grow to function as natural systems. In addition, we will produce hard data on how effective mangrove stands are in mitigating coastal erosion, a vital area in the face of predicted sea level rise.

4. *The biodiversity research community*: As described in 'Section 1,' understanding the relationship between diversity and ecosystem function is of fundamental ecological and conservational importance. Our project represents a unique and ambitious experimental test of how diversity might relate to important functions of mangrove forests.

Below is a list of institutions to which our results will be disseminated:

- Kenya Marine and Fisheries Research Institute
- Kenya Forest Department
- Kenya Wildlife Service
- Coast Development Authority
- Kenya Fisheries Department
- Ministry of Social Services
- Gazi community, the end users of the restored forests

We intend to publish in the scientific and popular press. Because of the general scientific interest in this area, and the novelty and ambitious scope of our work, we will submit the main findings to *Nature*. More specialist journals, whose readerships will have an interest in our work, include *Journal of Applied Ecology*, *Journal of Aquatic Botany*, *African Journal of Ecology* and *Restoration Ecology*. We will also submit to both international and local popular media such as *New Scientist* (where one of the PIs has published in the past), *Swara Magazine*, *East Africa Natural History Society*, and *The East African* a regional weekly newspaper.

In addition to printed media, we would hope to utilise the KBC (Kenya Broadcasting Corporation - TV and Radio) for publicity and dissemination; one of the PIs has been featured in several environmental programmes for KBC in the past.

5. FIELD TRAINING

Teams will receive the following introductory lectures/on-site training as either background or essential information for the project:

- *The ecosystem function/biodiversity debate* (MH)--a brief introduction to the field of biodiversity research, how biodiversity may be linked with ecosystem function and how it is being lost. This training provides the conceptual background for the research.
- *Introduction to Gazi village* (AR)--a guided tour around the village, including discussion of the ancient slave trading remains.
- *Introduction to mangrove ecology* (JK or MH)--discussion of mangrove zonation, ecology and physiology, as well as an introduction to the species found at the site.
- *Use of colorimeter, beach profiling tools and sediment analysis* (MH)--training in how to measure the physical and chemical variables.

- *Rationale and practices of mangrove restoration and management* (JK).
- *Crab, fish and macrobenthos quantification and identification* (MS or MH)--use of keys for East African crab, fish and macrobenthos taxa.

6. VOLUNTEER ASSIGNMENTS

Volunteers will be involved in the full range of tasks required in this project. The balance of work will change over the course of the project as follows:

Field Season	Tasks	Percentage of Volunteers' time
1	Measuring baseline variables at area 1 Identifying and quantifying fauna in the field and laboratory Planting trees	20 10 70
2	Measuring variables at area 1 Identifying and quantifying of fauna in the field and laboratory Profiling of the beach at area 2, and establishment of erosion stations Planting trees at area 2	25 10 10 55
3	Measuring variables at area 1 Measuring variables (including profiles) at area 2 Replanting lost seedlings at area 2 Identifying and quantifying of fauna in the laboratory	40 15 25 20
4	Measuring variables (including fish and prawns) at area 1 Measuring variables (including profiles) at area 2 Identifying and quantifying of fauna in the laboratory Replanting of lost seedlings at area 2	50 15 20 15
5	Measuring variables (including fish and prawns) at area 1 Measuring variables (including profiles) at area 2 Identifying and quantifying of fauna in the laboratory Replanting of lost seedlings at area 2	55 15 20 10

Because of the range of tasks involved, there is flexibility in the project to allow volunteers a degree of choice over what they do. We anticipate that the first field season will involve the most heavy physical labour (since the bulk of the trees will be planted in this season), and that the first two seasons should involve three sequential volunteer teams to allow sufficient time and labour to do the planting.

Useful skills and attributes of volunteers include good general fitness, group work skills and the ability to speak kiswahili.

7. PROJECT STAFF

PRINCIPAL INVESTIGATORS

Dr. Mark Huxham, Napier University. He is responsible for overall project management and logistics. His specialist areas include ecosystem functions, experimental design and analysis, macrobenthos and fish community structure.

Dr. James Kairo, Kenya Marine and Fisheries Research Institute. He is responsible for organisation of accommodation and laboratory space in Gazi, and for overseeing the mangrove planting and establishment (including nursery growth and culturing where necessary). His specialist areas include mangrove ecology, restoration and management.

Dr. Martin Skov, Lisbon University. He is responsible for advice on all aspects of crab surveying, capture and identification. His specialist areas include ecology of East African mangrove crabs and eco-physiology of crab nutrition.

RESEARCH ASSISTANT

Mr. Alfred Obinga, Kenya Marine and Fisheries Research Institute. He is a technician who lives in Gazi and has assisted several local and visiting scientists working on mangroves. His specialist areas include mangrove taxonomy, nursery establishment, natural regeneration and mariculture. His role in the project will be to lead a small team of temporary (seasonal) assistants involved in collecting and culturing propagules and providing field assistance to volunteers.

GRADUATE STUDENT

Mr. Bernard Kirui. He has just submitted his master's thesis to Egerton University on mangrove physiology, based on his work to date at the research site. He will look in more detail at the variables already described (in particular, measuring some key variables throughout the year) and consider other measures of productivity (e.g., leaf-fall).

VISITING SCIENTISTS

Mr. Jared Bosire, M.Sc., Kenya Marine and Fisheries Institute. He is studying the development of previous mangrove plantations at Gazi. He hopes to utilise our plots as additional sites for his study.

Ms. Beatrice Crona, M.Sc., Stockholm University. Her Ph.D. programme includes studying the development of fish and shrimp communities as mangrove plantations mature at Gazi. She hopes to use some of our experimental plots as part of this study.

RESEARCH STAFF TIMETABLE

Field Season	Research Staff Present
1	Mark Huxham, James Kairo, Martin Skov, Alfred Obinga
2	Mark Huxham, James Kairo, Alfred Obinga
3	Mark Huxham, Martin Skov, Alfred Obinga
4	Mark Huxham, James Kairo, Alfred Obinga
5	Mark Huxham, James Kairo, Martin Skov, Alfred Obinga

FIELD LOGISTICS

8. RESEARCH AREA



Gazi bay (4°25'S and 39°50'E), Kwale district, Kenya is located 55 km (34 mi) south of Mombasa, and can be reached in 1.5 hours on a relatively good road. The bay has a surface area of 18 km² (6.9 mi²), and is sheltered from strong sea waves by the presence of Chale Peninsula to the east and a fringing coral reef to the south. The reef supports a local subsistence and commercial fishery, with catches being landed on the main beach in the bay. On the landward side, Gazi bay is bordered by 6.2 km² (2.4 mi²) of mangrove forests. These forests are heavily used by local people as a fishing ground and a source of wood for building and fuel. Mangrove deforestation is widespread. The loss of mangroves affects the local economy as indicated by shortages of building poles and firewood, decreased fishery resources and increased coastal erosion.

The village has a resident population of 1000 people. It is supplied with clean, potable water and electricity. The climate is hot and humid, with average temperatures of around 28°C (82°F) and the greatest rainfall in May and November. Gazi is a safe and peaceful destination for an expedition. There is a rudimentary laboratory, owned by the Kenya Marine and Fisheries Research Institute, which will be used for storing and analysing samples. In the past (1994 and 1999), Gazi has successfully hosted pupils from the Yorkshire Schools Exploring Society for a total of 24 days in two trips. During their stay in the village, the group interacted with the local people in many ways, including football/soccer games and traditional dancing.

Gazi bay has beautiful beaches and impressive bird life, including three species of bee-eater, pelicans, palm vultures and hornbills. It is near to a black and white Colobus reserve, the tourist resort of Diani beach, the Shimba hills national park (famous for its elephants) and the Kisite-Mpunguti Marine National Park (with dozens of dolphins, sea turtles and spectacular coral reef snorkelling). There are many sites of historical interest on the coastline, including a ruin in Gazi that was once used as a concentration centre for slaves before they were shipped to Far East countries.

Gazi is a predominantly Muslim village, hence drinking in public, wearing very revealing clothing and open displays of sexual affection (e.g., kissing) should be avoided. The tourist areas at Diani beach attract some sex tourism. Getting involved in this is not recommended (for obvious reasons!) Kenyan culture places emphasis on respect, especially for elders, so it is useful to know the correct greetings and responses. Women travelling alone can sometimes be the subject of curiosity or harassment.

9. TRAVEL PLANNING

Visa Information

Citizens of the US, UK, Australia, and Japan will require a visa for entry to Kenya. This visa may be obtained at a Kenyan embassy or at the Nairobi airport for US\$50. Purchasing your visa before departure may help you avoid long lines at the Nairobi airport. One way to get a visa in the U.S. is to contact the Kenyan Embassy in Washington, D.C. at +1 202 387-6101. You may also download the visa application forms from the website at: <http://www.kenyaembassy.com>. Passports must be valid for at least six months past the date of entry into Kenya. Volunteers wishing to obtain a visa or passport within 6 weeks of their expedition are strongly encouraged to use a visa service.

Here are some Frequently Asked Questions about visas:

What kind of visa do I need?

Earthwatch volunteers, who require a visa for entrance, will need a tourist visa. The Principal Investigator/researcher will have the research permit or permission for the project.

How do I obtain a visa?

You can obtain a tourist visa by contacting the Embassy or Consulate of the country to which you are traveling. If you choose to obtain a tourist visa by directly contacting the country's embassy, please be sure to leave plenty of time, at least 6 weeks. If you have less than 6 weeks or wish to save yourself trouble, we strongly recommend using a visa agency, which can both expedite and simplify the process. The average cost of a visa is approximately US\$40--\$100 but varies country to country and can potentially cost up to US\$180. A visa agency will charge an additional fee (depending on the amount of time it takes to process the application), which you can inquire about directly.

What information do I need to provide?

You will need to send your passport, an application form, 2 to 4 passport-size photos plus payment to the embassy or visa agency (if applicable) at least 6 weeks in advance of departure. Please be sure that your passport is valid for at least 6 months beyond your stay.

What do I write on the visa application form as the "purpose of my visit?"

The purpose of your visit is for vacation, holiday, or travel. Foreign immigration officials do not always understand the concept of a "working vacation" or even "volunteering." Words such as "working/volunteering," "research" or a "scientific expedition" can raise questions concerning the country's foreign labor laws and/or prompt questions about official scientific research permits and credentials, etc. to which volunteers on their own will not be equipped to respond. All required research permits for the project are in place and have been approved by the proper authorities.

What do I write on the immigration form as the "purpose of my visit?"

The purpose of your visit is vacation, holiday, or travel.

What should I write for the place where I will be residing?

List the address of the hotel or project accommodations where you will be staying.

Where can I find more information on visas?

Please see "Helpful Resources" for several web site links related to the visa process.

Visa Agencies

IN THE UNITED STATES

Passport Visa Express.com
1911 North Fort Myer Drive, Suite 503
Arlington, VA 22209
Tel: 888 596-6028, +1 703 351-0992
Fax: +1 703 351-0995
Email: info@passportvisaexpress.com
Website: <http://www.passportvisaexpress.com/>

IN EUROPE

The Visaservice
Tel: +44 (0) 20 7833 2709
Fax: +44 (0) 20 7833 1857
Website: <http://www.visaservice.co.uk>

Thames Consular Services Ltd
Tel: +44 (0)20 8995 2492
Fax: +44 (0)20 8742 1285
Website: <http://www.visapassport.com>

Travel Agencies

The following agency is familiar with Earthwatch projects and can assist you in making travel arrangements and booking hotels:

FOR US VOLUNTEERS

Please call your Expedition Coordinator to inquire about recommended travel agents for your project.

FOR EUROPEAN VOLUNTEERS

Wexas International
London, UK
Tel: +44 (0) 20 7581 8761
Fax: +44 (0) 20 7581 7679
Email: southern@wexas.com
Quote code: EWE01/02

STA Travel
Oxford, UK
Tel: +44 (0) 1865 792800
Fax: +44 (0) 1865 792911
Email: manager.oxford@statravel.co.uk
Quote code: EWE01/02

For discounted student and youth fares, we recommend the following agencies which specialize in student discounts:

STA Travel
U.S.: 800 781-4040
U.K.: +44 (0) 1865 792800
Website: <http://www.statravel.com>

FOR AUSTRALIAN VOLUNTEERS

The recommended travel agent is familiar with Earthwatch projects, is in contact with the Australian Earthwatch coordinators and gives a discount where possible to Earthwatch volunteers. She is able to organise travel and travel insurance for volunteers Australia-wide.

Carlene Harlock
Shop 2, 250 Flinders Street
Melbourne, Vic 3000
Tel: +03 9663 6266
Fax: +03 9663 5100
Email: carlene_harlock.vic@flightcentre.com

If you notify your Earthwatch Coordinator prior to contacting this travel agent, your rendezvous information will be forwarded.

Cancellation Insurance

We highly recommend trip cancellation insurance which will help cover your airfare if you are unable to travel, or the expedition is cancelled. Earthwatch does not reimburse airfare or costs associated with cancelled flights. Contact your nearest Earthwatch office for details on cancellation insurance.

Other Advice / Information

Local Currency: The local currency is: Kenyan Shillings.

Electricity: Kenyan power is 240V with UK style three pin plugs

Time Zone: GMT/UTC +3

Personal Funds: Current exchange rates are approximately: £1: KS140; US\$1: KS77; €1: KS93 (as of March 2004), but this can change quickly. You will be able to change money at the airport (in Mombasa and in Nairobi)--although you will not get the best possible rates here, it is less of a hassle and you won't lose out too much. It is a good idea to bring larger denomination notes in dollars, sterling or euros. You can also bring travellers' cheques, although there is nowhere close to the field site where you can cash these, so you will need to have cash on you. Be careful with your money--there are plenty of pickpockets keen to relieve you of your money. So body hugging money belts and/or pockets with zips are useful.

Additional Information: The village is predominantly Muslim. So public drinking of alcohol is frowned upon, as is very revealing clothing (especially for women). The nearest town to the village is Ukunda, some 20 km (12 mi) away. There are facilities for changing money and withdrawing money from cash machines here. However, it is recommended that sufficient local currency be exchanged in Mombasa (at the airport if necessary) since the rates will be better there. Tipping is expected in the more expensive hotels and restaurants, but is not required in the cafés used by local people. Children may importune you for money. We ask you not to give it to them in the village, since this will encourage further pestering of future volunteers. Your work in

the village, and the money you will be bringing to the local economy, will be an important contribution to their future.

Volunteers Under 18 Years of Age

In an effort to prevent international child abduction, many governments have initiated procedures at entry/exit points. These often include requiring documentary evidence of relationship and permission for the child's travel from the parent(s) or legal guardian if not present. Having such documentation on hand, even if not required, may facilitate entry/departure.

In addition, airlines may also have documentation requirements for unaccompanied minors. Parents of minors are responsible for checking with each airline that their child will utilize to insure sufficient documentation. This could include a copy of a birth certificate or a notarized letter stating that the minor has his or her parent's permission to travel alone.

10. ITINERARY

- Day 1: Pick-up at the airport and transport to Gazi village. Welcome tour of the village and field site, and introductory talks about the local environment, health and safety and the restoration project.
- Day 2: Sampling and planting at the field site.
- Days 3-4: Sampling and planting at the field site, and sample sorting and analysis at the lab.
- Day 5: Free day, with time to rest, read, head into town or possibly join a group excursion to Shimba Hills elephant reserve or Kisite-Mpunguti marine national park. The former will cost around US\$50 per person for transport and park fees; the latter around US\$35.
- Day 6-7: Sampling and planting at the field site.
- Day 8: Finishing off sampling and laboratory work.
- Day 9: Packing up and return to Mombasa.

Unorganised free time activities might include reading, bird watching, walking on the beach, football/soccer, trips to the local town (for shopping and internet access) and evening trips to local bars.

The tourist beaches at Diani are 20 km (12 mi) away. They are beautiful but can be dangerous, especially after dark. So volunteers should not go to these areas alone or after dark. They should also be sensitive to their hosts and not return late from local bars, etc. Swimming in some areas of the Bay might be dangerous and is not recommended.

Volunteers should consult a travel guidebook for information on local attractions. See "Helpful Resources."

11. DAILY SCHEDULE

Volunteers should be aware that schedules can and do fluctuate. Weather and work conditions can affect the daily schedule. Should this situation arise, your cooperation and understanding are appreciated.

A detailed example schedule is given here. Most days will consist of at least 3 hours work in the field, but the timing of this work will depend on the tides. We will require relatively more field time early in the project (because of the tree planting), and relatively more laboratory work later in the project (because of the higher numbers of samples/observations). There may be some night work required during fishing.

0700-0800 hrs Breakfast

0800-0830 hrs Daily briefing

0830-0930 hrs Preparation then travel to field site

0930- 1230 hrs Field work

1230-1530 hrs Return to Gazi. Lunch, resting and lab work

1530-1800 hrs Further field work for some group members, lab work for others

1800-1900 hrs Supper

1900-1930 hrs Debriefing, any necessary discussion of evening's activities

12. TEAM DEVELOPMENT

The team will work together or in at most two teams operating at the two different sites. All team members and PIs will share accommodations and meals, and evening events will be arranged for all members.

13. ACCOMMODATIONS

You will be accommodated in one or two houses in the village. The houses are supplied with electricity, although this can be unreliable; Kenyan power is 240V with UK style three pin plugs. There will be at least one shower (cold water only) available for volunteers, and either a flush or pit toilet (both of them squatting rather than sitting). We will do our own laundry by hand, so please bring clothes that are easy to wash. In most cases, you will share a room with one other person, each with a separate bed. There may be some people who will have their own rooms or who will share with two others, depending on final numbers. It should be possible for couples to

share a room provided they inform Earthwatch early. Plenty of clean, potable water is available in the village; it may be necessary for some of us to collect water from the village wells.

You will need your own towels and bedding. It is warm even at night, so a sheet sleeping bag or very light summer sleeping bag will be sufficient. We also recommend that you bring a mosquito net. The larger type, with plenty of room to roll over, is best.

The village is 2 km (1.2 mi) from our close field site and 6 km (3.7 mi) from our distant one. We will walk to the former and usually drive to the latter, although it may be necessary to walk on occasions.

14. FOOD

The evening meal will be prepared for us by a cook. We will take food with us to the field, and lunch will consist of snacks bought locally (because of the hot climate, lunch is usually a light meal).

Most of the food is low fat and low sodium, and is also low in refined sugars (so it should be acceptable for diabetics). Vegetarians may miss out on some of the main dishes at supper (beef, goat, chicken and fish are mainstays of the local diet), but alternatives should be possible.

All research staff will be housed with and eat with volunteers.

Here is a sampling of the foods you might expect in the field. Please bear in mind that variety depends on availability. This list is intended to provide a general idea of food types. It is very important that volunteers be flexible.

Breakfast:	Fruit, omelettes.
Lunch and snacks:	Fruit, nuts, Chapatis, mandazi (a kind of doughnut), peanuts, biscuits and cake are all available from the village shop.
Dinner:	Soup, rice, beans, stew, fresh fish, maize porridge, beef, goat.
Beverages:	Tea and coffee will be served with the evening meal. Cold sodas (coke, etc.) are sold in the village shop.

Special Dietary Requirements

Note: Please alert your Earthwatch Expedition Coordinator to any special dietary requirements as soon as possible (e.g., diabetic, lactose intolerant, etc.). Accommodating any special diets is not guaranteed and can be very difficult due to availability, location and local conditions.

Special note to vegans and strict vegetarians: Please be aware that it is often difficult to accommodate strict vegetarians and vegans. It may be possible to get meatless meals but vegans and strict vegetarians may have a problem avoiding animal products altogether. If this poses a problem, then participation on an Earthwatch expedition should be seriously reconsidered.

At Gazi, there will be plenty of vegetarian food available, although this may consist of simply taking the meatless part of the main meal. Likewise, predominantly vegan food will also be

available. However, very strict separation of foodstuffs may be a problem. Sufferers from severe nut allergy need to be very cautious, since peanuts are a common part of the diet.

15. PHYSICAL CONDITIONING

Please show this section to your physician when he/she is completing your health statement.

To the examining physician:

Your patient has volunteered to join the field research team which has specific physical demands of which you and your patient should be aware. **We need your accurate evaluation of your patient's ability to meet the conditions detailed below in order to safeguard his/her health and safety, and ensure that s/he can participate fully and effectively.**

Overview

The project will involve physical activity in a hot, humid environment. So heart conditions would be of concern. There are no facilities for wheelchair users and any other serious impairments to mobility would be problematic. Visual impairments would also prevent participation in most activities. Skin complaints (such as severe psoriasis or eczema) which are very aggravated by salty/dirty water would also cause problems.

Mosquito bites must be minimised, so insect repellent is vital, as are mosquito nets and mosquito coils/electric burners. Malaria prophylactics should be taken so please speak with your physician about the best option available for you. Volunteers need to minimise the risk of sunburn and heat exhaustion, so sun hats, sensible clothing and dark glasses are important.

General Conditions

Humidity	High		
Temperature Range:	65°F/18°C	to	86°F/30°C
Altitude	Sea level		
Rainfall	4 in/9 cm	per	month (in July)

Climate and terrain of the research site

Both research sites are flat beach areas, exposed to the sun. Likely rainfall and downpours possible, but the climate is likely to be dry for later teams.

Physical Demands

	Workload/Intensity	Time (hours per day)/#of days per team
Sitting		2/6
Bending		4/6
Hiking		0
Walking	15 kg (33 lb) per person for 6 km (3.7 mi)	2/6
Digging	with spades	4/6

Medical Conditions of Special Concern

If you have very limited mobility, you will struggle with the unpaved sandy beaches, local paths and roads. Any conditions aggravated by heat and humidity may be cause for concern. Although we will not walk long distances, we will work in the sun for hours at a time, which can be tiring and physically demanding. So a good level of fitness is essential. Those with back or knee problems would not be able to fully contribute as they may have difficulty digging and planting. You will be able to work at your own pace when planting trees. Mangrove propagules are much easier to plant than most terrestrial trees!

Potential Hazards

There are two main hazards associated with working and travelling on the coast of Kenya: malaria and aggressive robbery. The first must be avoided using the appropriate chemical prophylaxis, by covering up and using mosquito repellent and nets. The second is not a threat at our field site, but is a problem in larger towns and tourist resorts. You will be advised on safe places to go, but you should use common sense when travelling to and from the site (for example, avoid going out alone at night in Nairobi or Mombasa).

Volunteers may be exposed to heat, humidity and direct sunlight for many hours at a time. Protective clothing and high SPF sunscreen are essential. Volunteers must take care to avoid dehydration, sunburn, heat stress, etc.

Diseases found in Kenya include malaria, dengue fever, filariasis, leishmaniasis, onchocerciasis, trypanosomiasis, schistosomiasis, hepatitis, typhoid, and HIV/AIDS. Please see Section 17 for inoculation recommendations. Most diseases are prevented with basic safety cautions. Please see the CDC (www.cdc.gov) or WHO (www.who.int) websites for more information.

Snakes are found in the study areas. Stonefish, which have highly toxic spines, and jellyfish, though rare, may be found in the coastal waters.

Proximity to Medical Care

Is there a physician, nurse, or EMT on staff?

No

Staff certified in CPR (Cardiopulmonary Resuscitation), First Aid, or other safety training (i.e. Wilderness First Responder, Water Safety, etc.)?

Yes - Mark Huxham , with current certification as a workplace First Aider.

What is nearest hospital location?

Msambweni hospital, 10 km (22 mi) from Gazi.

Time to reach?

30 minutes

16. MEDICAL ADVICE

Inoculations

The following are recommendations only. Health conditions around the world are constantly changing, so keep informed and consult your local travel health clinic, the U. S. Center for Disease Control (www.cdc.gov) or the World Health Organization (www.who.org) websites. Medical decisions are the responsibility of each volunteer. Please consult your physician, your local Public Health Department, or the resources listed below for the latest health information for travelers.

	Required for Entry	Recommended for Health Reasons
Polio		X
Diphtheria		X
Tetanus		X (up to date)
Typhoid		X
Yellow Fever	X - if traveling from countries or region where it is endemic, a Certificate of Vaccination is required.	
Hepatitis A		X
Cholera	*	

Is Malaria present at the research site?

Yes - it is a serious risk to locals and travelers.

If yes, is the malaria parasite chloroquine resistant?

Yes, there is resistance to chloroquine in this area of Africa. It is important that you consult with your doctor to discuss the best anti-malarial drug for you. Many of the anti-malarials have side effects that are particularly serious for some small groups of people. Malarone seems effective and there is no reported resistance. Volunteers need to minimise the risk of sunburn and heat exhaustion, so sun hats, sensible clothing and dark glasses are important.

* Cholera may be present in the research area. In 1973 the WHO, recognizing that immunization cannot stop the spread of cholera among countries, deleted from the International Health Regulations the requirement of cholera immunization as a condition of admission to any country. In 1990 the WHO stated that immunization against cholera was not effective and they do not recommend it. In 1991 the WHO confirmed that certification was no longer required by any country or territory.

Tuberculosis (TB): The World Health Organization (WHO) estimates that one third of the world's population is infected with the bacterium (*M.tuberculosis*) that causes tuberculosis (TB). Incidence of tuberculosis is higher in developing countries, particularly in Asia, Africa, the Caribbean and Latin America. In general, approximately 10% of persons infected with *M. tuberculosis* are at risk for developing active TB during their lifetimes. TB is considered highly treatable with medications that are of relatively low toxicity and cost. Volunteers returning from developing countries are encouraged to have a (PPD)-tuberculin skin-test to screen for potential infection.

These recommendations are for this project site only. Please consult your physician for guidance on inoculations if you intend to travel to other parts of the country.

Resources

Earthwatch recommends that you consult your local public health department or one of the following resources for the latest health information for travelers.

US ONLY

Centers for Disease Control
Atlanta, GA, U.S.A.
Phone: 800 311-3435 or 888 232-3228
Website: <http://www.cdc.gov>

UK ONLY

Hospital for Tropical Diseases Healthline
Phone: 0906 1 337733 (within UK)
(calls are charged at 50p per minute)

MASTA Travelers' Healthline
Phone: 0906 8 224100 (within UK)

AUSTRALIA ONLY

The Travel Doctor - clinics Australia wide
Travel Doctor Hotline: 1300 658 844 (within AU)
Website: <http://www.tmvc.com.au>

GENERAL INFORMATION

Disease Outbreaks:
<http://www.who.int/disease-outbreak-news/>
or
<http://www.istm.org/news.html>

17. EMERGENCIES IN THE FIELD

Very minor injuries (cuts and bruises, sunburn, etc.) will be treated using first aid kits at the site. There is a local clinic for any slightly more serious problems, and a well equipped hospital at Msambweni, 30 minutes away by road. A vehicle will be available for emergency evacuations. In the case of very serious emergencies, evacuation by road to Mombasa is possible in under two hours.

Emergency contact number at Earthwatch headquarters in the U.S.: +1 978 461-0081.

After business hours, leave your message with our answering service. State that you have an emergency communication and leave a clear message with the name of the expedition, your name, location you are calling from, and if possible, a phone number where you can be reached. An Earthwatch staff person will be paged and will respond to your call.

International Evacuation Insurance

UNITED STATES OFFICE:

The travel medical and evacuation insurance, coordinated by ISIS Assistance, is mandatory for all Earthwatch volunteers while they are on an Earthwatch expedition anywhere in the world. The insurance covers volunteer travel medical risk, including medical expenses and medical evacuation, while you are traveling with Earthwatch overseas or on an expedition within your home country. ISIS Assistance will also facilitate evacuation from the project site in the event of an emergency. Without insurance, the costs of such measures can be on the order of US\$20,000 to \$50,000.

A detailed description of the Earthwatch Volunteer Travel Medical Insurance Program policy will be sent with this briefing. The policy is summarized in a user-friendly questions answer format. Please contact your Expedition Coordinator if you have further questions.

Earthwatch Institute's insurance provider, ISIS Assistance, provides a 24-hour emergency hotline for the use of insured persons under the Earthwatch program. ISIS Assistance can help with medical emergencies, doctor and hospital selection, obtaining additional medical options, or medical translation problems. ISIS Assistance is backed by International SOS and Global Medical Management, who provide emergency medical evacuation and rescue services. The Earthwatch policy certificate number is US 011300. In addition, each individual policy is identified by the volunteer's Earthwatch ID number, shown above your name on your team list.

In an emergency - If you are calling from **outside of the US**, the number to call is: +44 (20) 8762 8015. You may call this number collect.

In an emergency - If you are calling from **inside the US**, the toll-free number to call is: 888 422-4747.

Basic coverage is valid in the country of your Earthwatch expedition, and during international travel to and from your expedition. For volunteers on Earthwatch expeditions in their own country, coverage begins when your group forms for the expedition, and ends when the group disbands. Options are available for volunteers who would like to extend the period of coverage, increase insurance amounts or purchase additional cancellation or baggage insurance.

EUROPEAN OFFICE:

Earthwatch Europe offers travel and medical insurance provided by Royal & SunAlliance. In the event of medical assistance or an evacuation being necessary, ISIS Assistance will be notified. ISIS Assistance will coordinate the evacuation in conjunction with International SOS.

FOR ALL OTHER VOLUNTEERS:

In addition, our affiliate offices in the Australia and Japan have recommendations for their volunteers. Please contact your nearest Earthwatch office for more information. You may also try the following website which lists several travel insurance providers. Click on the "Travel Insurance" link, which is located on the right in a box called "Healthy Travel Store" (just under the Visa sign). Website: <http://www.travelhealth.com/home/>

18. WHAT TO BRING

Note: Do not bring more luggage than you can carry and handle on your own. We recommend that you pack a carry-on bag with an extra set of field clothing and personal essentials in the event that your luggage is lost and/or takes several days to catch up with you.

It is useful to bring a small field rucksack to carry field gear, food and water.

General Considerations

Volunteers are likely to remain wet or dirty for extended periods. We may work in mangrove environments for up to 6 hours at a time. So bring light, easily washed clothing.

Cultural Considerations

Gazi village is predominantly Muslim. So public drinking of alcohol is frowned upon, as is very revealing clothing (especially for women).

Extreme weather

The weather should be warm and dry for most of our time in Gazi. However, it may rain, sometimes very heavily. Be aware of protecting yourself from the sun; sun hats, dark glasses and sunscreen are all recommended.

Required

Clothing/Footwear for Fieldwork

- Light weight, quick drying, long-sleeved shirts and trousers
- Well worn in and comfortable walking shoes or hiking boots
- Sun hats
- Dark sunglasses

- Sturdy sandals and light boating shoes, trainers (or ideally tough neoprene diving boots) for work in water

Clothing/Footwear for Leisure

- One nice set of clothing for evening in town or to keep clean for end of expedition

Field Supplies

- Small daypack/rucksack, 20 L (1 qt) pack useful for excursions and carrying water and food during the day
- Drybag or plastic sealable baggies (good for protecting equipment such as camera from dust, humidity, and water)
- Insect repellent (DEET is best)
- Water bottle(s)

Bedding and Bathing

- Towel
- Light sleeping bag or sheet sleeping bag
- Mosquito net

Personal Supplies

- Personal toiletries (we recommend bringing biodegradable soaps and shampoos)
- Antibacterial wipes or lotion (good for “washing” hands while in the field)
- Personal first aid kit (anti-diarrhea pills, antibiotics, antiseptic, itch-relief, pain reliever, bandages, moleskin, etc.). Personal medications and malaria prophylaxis.
- Sunscreen lotion with SPF 30 or higher

Miscellaneous

- Spending money. Cash in dollars, sterling or euros can be easily changed in Mombasa, as can travellers’ cheques
- Camera, film, extra camera battery

Recommended:

- Flashlight/torch or headlamp with extra batteries
- Snorkeling gear for marine park
- Warmer clothing (one jumper/sweater) for Shimba Hills

19. HELPFUL RESOURCES

- <http://www.specola.unifi.it/mangroves/Index.htm>
Specific to East African mangroves, notably Kenya. Includes botany, faunal descriptions and general ecology. Contains many useful links to other websites.
- <http://www.glomis.com/isme/>
The official website of the International Society for Mangrove Ecosystems.
- Useful Visa Information website: <http://www.embassyworld.com>
- Airport Codes Worldwide: <http://www.logisticsworld.com/airports.asp>
- Lonely Planet travel guidebooks and online travel site: <http://www.lonelyplanet.com>.
Their guidebooks can be purchased from their website.
- The Rough Guide travel guidebooks and online travel site:
<http://travel.roughguides.com/>
- Cheap Flights: <http://www.travelix.com/> or <http://www.discountair.com/>
(worldwide)
- Country Reports. Country information from around the world. Website:
<http://www.countryreports.org>
- National Geographic Map Machine. Website:
<http://plasma.nationalgeographic.com/mapmachine>
- U.S. Travel Clinic Directory: <http://www.astmh.org/scripts/clinindex.asp>
- Travel Health website: <http://www.mdtravelhealth.com> is a resource for healthy travel.
Covers country-specific risks and diseases, suggested immunizations, and health recommendation, and locating a travel clinic near you.
- U.S. State Department: <http://www.state.gov/>
- UK Foreign Office travel advice: <http://www.fco.gov.uk/travel>
- World Time Server: <http://www.worldtimeserver.com/> [time worldwide with GMT/UTC] or <http://worldbuddy.com/> or <http://www.hilink.com.au/times/>
- Currency Converter: <http://www.xe.com/ucc/>
- Telephone Dialing From and To Anywhere: <http://kropla.com/dialcode.htm>
- Online Unit Conversions: <http://www.onlineconversion.com/>
- Worldwide Weather: <http://www.worldweather.com/> or
<http://www.wunderground.com>
- ATM Locator:
http://visaatm.infonow.net/bin/findNow?CLIENT_ID=VISA
<http://www.mastercard.com/atmlocator/index.jsp>

- Heat Index (temperature, dewpoint and relative humidity):
<http://www.weatherimages.org/data/heatindex.html>
- Exhaustive List of Weather Resources:
<http://cirrus.spri.umich.edu/wxnet/servers.html>
- Third World Traveler - offers many links for useful travel information:
http://www.thirdworldtraveler.com/Travel/Travel_Links.html

20. THE READING LIST

Huxham, M., and Sumner, D. (eds) (2000). *Science and Environmental Decision Making*, Pearson Educational Ltd., Harlow. - Chapter 6 of this book provides an introduction to the biodiversity/ecosystem function debate, and looks at some of the arguments for conservation.

Daily, G.C. (ed). 1997. *Nature's Services. Societal Dependence on Natural Ecosystems*. Island Press, Washington. - This gives an extensive overview of ecosystem services.

Hogarth, P.J. (1999). *The biology of mangroves*. Oxford University Press. - This is a recent text covering most aspects of mangrove ecology, species biology, and conservation.

Tomlinson, P.B. (1986). *The botany of mangroves*. Cambridge Tropical Biology Series, Cambridge University Press. - The bible on mangrove tree botany. Includes short parts on tree ecology

Saenger, P. 2002. *Mangrove ecology, silviculture and conservation*. Kluwer Academic Publishers, Dordrecht, the Netherlands.

LITERATURE CITED

Abuodha, P & J. G. Kairo, 2001. Human-induced stresses on mangrove swamps along the Kenyan coast. *Hydrobiologia*, 458: 255 - 265

Bolam, S., Fernandes, T. and Huxham, M. (2002). Diversity, biomass and ecosystem processes in the marine benthos. *Ecological Monographs* (in press).

Emmerson, M. and Huxham, M. (2002). How can marine ecology contribute to the biodiversity-ecosystem function debate? In Loreau, M., Naeem, S. and Inchausti, P. (eds) *Biodiversity and Ecosystem Functioning: Synthesis and Perspectives*, Oxford University Press, Oxford.

Huston, M. A. 1997. Hidden treatments in ecological experiments: re-evaluating the ecosystem function of biodiversity. *Oecologia* 110:449-460.

Kairo, J. G. 1995a. Artificial regeneration and sustainable yield management of mangrove forests in Kenya. MSc. Thesis University of Nairobi, Botany, Kenya.

Kairo, J. G. 2001. Ecology and restoration of mangrove systems in Kenya. Ph.D. Dissertation. Laboratory of Plant Sciences and Nature Management, University of Brussels (VUB), Belgium.

Kairo, J. G., F. Dahdouh-Guebas, J. Bosire & N. Koedam 2001. Restoration and management of mangrove systems - a lesson for and from the East African region. *South African Journal of Botany*, 67: 383-389

MacNae, W. 1968. A general account of the fauna and flora of mangrove swamps and forests in the Indo-Western Pacific Region. *Advances in Marine Biology*, 6, 74.

Pearson, T. H., and S. O. Stanley. 1979. Comparative measurement of the redox potential of marine sediments as a rapid means of assessing the effect of organic pollution. *Marine Biology* 53, 371-379.

Skov MW, Cannicci S, Hartnoll RG, Vannini M (in press) Quantifying the density of mangrove crabs: Ocypodidae and Grapsidae. *Marine Biology* (2002)

Spalding, M. F.B lasco and C. Field 1997. *World Mangrove Atlas*. International Society of Mangrove Ecosystem, Okinawa, Japan.

Thompson, T.L. and Glenn, E.P. 1994. Plaster standards to measure water motion. *Limnology and Oceanography* 39, 1768-1779.

Tilman, D. 2000. Causes, consequences and ethics of biodiversity. *Nature*. 405: 208-211.

Wolanski, E., and Ridd, P. V. 1986. Tidal mixing and trapping in mangrove swamps. *Estuarine, Coastal and Shelf Science* 24: 759 - 771.