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Introduction

The project entered the inception phase after the presentation of the draft Inception Report at the end of August. The period September 1st to December 31st was spent on detailed planning of the inventory procedures, training of forestry department staff, and recruitment of additional inventory staff. In January 2009 the project will enter the field data collection phase, during which intensive field data collection efforts will be made.

This interim report describes the project activities from September to the end of December 2008. The report focuses on providing a summary of activities. Background detail is provided either in supporting papers or Annexes.

A major difficulty has been starting the boundary survey component of the project. Negotiations with the candidate for Principle Surveyor have not proceeded smoothly. As a result a new direction is required. FCG is preparing a proposal to adopt a revised approach to the boundary survey. The report includes details of the revised approach

Background

The Ministry of Agriculture, Lands, Fisheries and Forestry of St Lucia promotes and supports the conservation of the country's natural resource base for the benefit of the entire population. The Forestry Department, in collaboration with the Crown Lands Division of the Ministry of Physical Development and National Mobilization, has identified all the lands adjacent to the Forest Reserves and has made recommendations for their vesting/acquisition and eventual incorporation into the existing Forest Reserve Management System. However, before reaching that point, these lands have to be surveyed, demarcated on the ground with standard physical markers, vested in the Crown, or acquired, and declared legal Forest Reserves. In addition, the existing forest reserve boundaries need to be re-demarcated.

The Forestry Department is the principle agency responsible for managing forest and wildlife resources on the island of St. Lucia. The Forestry Division of St. Lucia was established in 1946, upgraded to the status of Forestry Department in 1984 and is currently supervised by a Chief Forest Officer

This project is funded by the European Community under the Saint Lucia SFA2003 Programme Economic and Agriculture Diversification and Poverty Reduction Through Integrated National Resources Management. The Banana Industry Trust is the Grant Beneficiary and Manager of a component of the Programme "Environmental Management Fund".

The overall objective of the project is:

> "To survey and demarcate the physical parameters of the public forest reserve and conduct a comprehensive biophysical inventory/assessment and management system of forest resources to produce, inter alia, a forest resource monitoring system, obtained through ground survey, remote sensing, assessment and review of existing data that will serve as the basis for strategic sustainable planning and management of forest resources".

The purposes of the service contract are:

i. To survey and demarcate and realign the Forests Reserves boundaries, inter alia incorporating the newly acquired crown lands, in order to facilitate better protection and management;

ii. To create an updated data base of Forest Reserve boundary line (digital and hard copy data, to reside at Forestry Department and Lands and Surveys Department) and measure the quality, quantity and distribution - inclusive of yield and volume - of timber and non-timber resources, and to compile statistics of their availability at the range, watershed and national level.

iii. To assess the status of the forest ecosystem, assessment of biodiversity (species richness and diversity) and all existing vegetation type at the watershed, range, and national level.

iv. To advise on the most optimal means/measures for the sustainable management (utilization and conservation) of forest resources

v. To recommend relevant silvicultural and utilization prescriptions necessary for planning and management of forest resources

vi. To assess all existing forestry related database, and to create an updated monitoring system for producing forest resource state and change estimates;

vii. To provide spatial and statistical data for estimating the nature, magnitude, geographical scope, in relation to Timber and NTFP yield and volume, biodiversity, carbon storage, and processes

viii. To conduct a training programme to develop the capacity of a cadre of persons in forests resource assessment and inventory method and forests management system using, scientific and modern technology

ix. To recommend and implement an effective, efficient and appropriate forest management system for Saint Lucia.

Information dissemination for the public awareness and support is crucial for the successful implementation of this project. Organising consultations with and briefing sessions for key stakeholders for the presentation of the forest demarcation and biodiversity assessment work plan, and conducting meeting with major communities that are directly or indirectly linked to the forest reserves and other important forest ecosystems that will require conservation interventions, are essential for getting the community support and acceptance for the work of the project. Past experience shows that support is best generated by close involvement through a consultative and participatory management approach.

The project commenced in July 2008, and a revised Inception Report was accepted in October. The project is now in the Implementation Phase, and has been carrying out planning activities for the period of this report. The next phase will be an intensive field work phase.

Major Project Activities

During the Inception Phase a training needs analysis was carried out, which identified a need for inventory training. Training was placed high on the list of activities to be carried out early in the Implementation phase. The first training activity was a Timber Inventory training program, followed by a Bioresource Training program.

The two training programs are described in detail below.

The other main activities during the period from September to December 31st were planning activities, and recruitment of non-key experts and field staff. These activities are also described in detail below, cross referenced to the project documentation to show how the activities contribute to the project outputs.

Timber inventory training

A timber inventory training course was held based in the FD conference room at Union from October 29th to October 31st. The course was attended by 30 people, consisting of 25 FD staff and 5 prospective inventory employees.

The course included the following components:

1. Basic mensuration
2. Species identification
3. Inventory design
4. Emergency procedures

The course included lectures supplemented by field exercises. During the lectures theoretical material was presented, with the field exercises including practical application of the material covered in the lectures. The participants learned how to accurately measure tree diameters and heights, and how to lay out a field sample plot.

The participants completed two sets of exercises which enabled their knowledge to be graded. The results of the grading will be used to assist in the selection of candidates for inventory field work.

An inventory training manual was produced for the course. Copies have been sent to the BIT. An outline of the course manual is included in Annex 1.

The timber inventory training course contributed to the following aspects of the project ToR and work plan.

2.2 Purpose

viii. To conduct a training programme to develop the capacity of a cadre of persons in forests resource assessment and inventory method and forests management system using, scientific and modern technology

2.3 Results to be achieved by the Consultant

x. A cadre of locally trained individuals with sufficient capacity and skills to function in a forest inventory/assessment environment and at least 2 local persons who can manage a forest management system.

4.2 Specific Activities

2. xx. Conduct training workshops for a cadre of local persons, including forestry officers, which will form part of the biophysical inventory and forest boundary line surveying team.

Work Plan Milestones

Bio-resource inventory training to be completed by early November 2008

Biodiversity survey training

A biodiversity survey training course was held based at the Palm Haven Hotel between December 3rd and December 5th. The course was attended by 18 trainees, consisting of 3 prospective employees and 15 FD staff members.

The course included training on the following aspects of biodiversity survey.

- Forests and Forest Wildlife on St Lucia
- Map Reading
- Surveying Forest Species
- Surveying Forest Animals
- Interview techniques
- Recording Information
- Navigation
- Field Craft and Safety

The course included lectures supplemented by field exercises at the Union office forest. During the lectures theoretical material was presented, with the field exercises including practical application of the material covered in the lectures. The participants took part in an exercise to observe birds and other forest fauna.

An outline of the course is included in Annex 2**.**

The biodiversity survey training course contributed to the following aspects of the project ToR and work plan.

2.2 Purpose

viii. To conduct a training programme to develop the capacity of a cadre of persons in forests resource assessment and inventory method and forests management system using, scientific and modern technology

2.3 Results to be achieved by the Consultant

x. A cadre of locally trained individuals with sufficient capacity and skills to function in a forest inventory/assessment environment and at least 2 local persons who can manage a forest management system.

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2. xx. Conduct training workshops for a cadre of local persons, including forestry officers, which will form part of the biophysical inventory and forest boundary line surveying team.

Work Plan Milestones

Bio-resource inventory training to be completed by early November 2008

Timber inventory design

During the period covered in this report the forest timber inventory methodology was prepared. A draft plan was presented to the Technical Committee on 15th December 2008, which leads to a revised design. The inventory design is based on the following principle features

1. Stratified sampling, with sample intensity varying between strata
2. Strip plots using a random interval between plots
3. Measurement of all trees above 5 cm dbh
4. Calculation of volume from volume functions
5. Analysis of inventory result using the FMIS

The full inventory design is included in Annex 3.

The Timber Inventory design contributed to the following aspects of the project ToR and work plan.

2.2 Purpose

iii. To assess the status of the forest ecosystem, assessment of biodiversity (species richness and diversity) and all existing vegetation type at the watershed, range, and national level.

vii. To provide spatial and statistical data for estimating the nature, magnitude, geographical scope, in relation to Timber and NTFP yield and volume, biodiversity, carbon storage, and processes

2.3 Results to be achieved by the Consultant

v. A comprehensive report on the current state of forest resources (Timber, Non-Timber, biodiversity, wild fauna etc), with recommendations for sustainable management practices. The report should include, but should not be limited to, the following key considerations:

c. Inventory Design;

4.2 Specific Activities

The inventory framework should be universally applicable irrespective of the forests type and geographical location and the design of the framework should be cost effective and flexible enough to permit adaptability to changing trends.

ii. The inventory must be scientifically defensible, be based on internationally acceptable methodology and presented in a form that demonstrates a logical progression in the conduct of the assignment.

iii. The inventory process must be replicable.

iv. The forest inventory must employ standard terminology and quantifiable field sampling and data analysis methods, so levels of confidence can be documented.

v. The inventory methods employed should be widely accepted both nationally and internationally.

vi. The inventory design should take advantage of the information available from previous inventories,

vii. The inventory must classify existing biological associations that repeat across the landscape.

viii. The inventory units must be ecologically meaningful (relating to watershed boundaries wherever possible).

ix. The inventory units must be mappable from polygons that are discernable oil imagery.

x. The system of assessment must be hierarchically organized such that it can be applied at different spatial scales.

xi. This system must identify units at an appropriate scale to meet the objectives for resource management and biodiversity conservation,

xii. The system must be flexible and open ended such that it will allow for additions, modifications, and continuous refinement.

Work Plan Milestones

Forest resource inventory design and sampling plan to be completed by early December 2008

Preparation of prototype FMIS

During the period covered in this report work was carried out on the development of a prototype FMIS, to be presented in January 2009. The prototype FMIS has been prepared in Microsoft Access, and has an initial focus on the components covering the processing of inventory data, as this will be the first task to be implement with the FMIS.

The prototype FMIS will include an almost complete inventory data processing component, prototype inventory analysis reports, a prototype PSP module, as well as prototype forest harvesting and forest growth modules. The prototype will be used to obtain FD feedback on elements which are of most use to the FD.

The prototype FMIS will contribute to the following aspects of the project ToR and work plan.

2.2 Purpose

vi. To assess all existing forestry related database, and to create an updated monitoring system for producing forest resource state and change estimates;

vii. To provide spatial and statistical data for estimating the nature, magnitude, geographical scope, in relation to Timber and NTFP yield and volume, biodiversity, carbon storage, and processes

2.3 Results to be achieved by the Consultant

vi. An updated and functional forest resource monitoring system which should include:

a. Permanent sample plots;

b. Yield tables and other tools for measurements of changing variables;

c. An upgraded and integrated data base, with biodiversity, wildlife, forest, botanical inventory data;

ix. A forest management system in place and functioning;

4.2 Specific Activities

xiii. The results should be analyzed, maintained and presented in the form of a GIS and geo-reference database linked specifically to other inventories,

Work Plan Milestones

Prototype FMIS released

Health and safety guidelines

During the period covered in this report the Project Key Experts contributed to the preparation of a set of health and safety guidelines to be used in the project field activities, as well as the related Parrot survey and general FD operations.

The Health and Safely guidelines contain the following sections.

- Emergency contacts
- Code of conduct
- Hazards
- General Health Care
- Infectious diseases

The Health and Safety Guidelines will be a living document, to be updated on an ongoing basis. The most recent version of the guidelines is included in Annex 6.

The health and safety guidelines contribute to the following aspects of the project ToR and work plan.

2.2 Purpose

iii. To assess the status of the forest ecosystem, assessment of biodiversity (species richness and diversity) and all existing vegetation type at the watershed, range, and national level.

2.3 Results to be achieved by the Consultant

x. A cadre of locally trained individuals with sufficient capacity and skills to function in a forest inventory/assessment environment

4.2 Specific Activities

xx. Conduct training workshops for a cadre of local persons, including forestry officers, which will form part of the biophysical inventory and forest boundary line surveying team.

GIS establishment

A major achievement of the period covered in this report was the establishment of the project's GIS system. The project GIS and Data Management Specialist, Mr Vijay Datadin, made his first visit to St Lucia to provide input from November 9th until December 19th. During his mission he set up the GIS system on the computer purchased for the system, and imputed all available data from the FD GIS section. He also acquired data from other sources including Mr Matthew Morton. He worked to prepare forest boundaries for the timber inventory survey, and a vegetative cover map for the Bioresource survey.

Mr Datadin also configured the project's HP Design Jet 130 large format printer, and began the production of maps for use in the project, and for the use of the FD. He also worked with the Project Leader to ensure that the FMIS being developed to store and process attribute data was compatible with the GIS system under development. An example from the maps produced is included in Annex 7.

Due to the problems with the engagement of a Principle Surveyor the GIS and Data Management Specialist was unable to work with a Surveyor Draftsman. The components related to the production of maps using AutoCAD will be covered in the next visit of this Key Expert.

The establishment of the project GIS system contributed to the following aspects of the project ToR and work plan.

2.2 Purpose

ii. To create an updated data base of Forest Reserve boundary line (digital and hard copy data, to reside at Forestry Department and Lands and Surveys Department) and measure the quality, quantity and distribution - inclusive of yield and volume - of timber and non-timber resources, and to compile statistics of their availability at the range, watershed and national level.

vii. To provide spatial and statistical data for estimating the nature, magnitude, geographical scope, in relation to Timber and NTFP yield and volume, biodiversity, carbon storage, and processes

2.3 Results to be achieved by the Consultant

iii. Digital and physical plans/maps, reports, data and other information on land of all forests reserves produced from surveying and demarcation of the forests reserves boundary line survey;

vi. An updated and functional forest resource monitoring system which should include:

c. An upgraded and integrated data base, with biodiversity, wildlife, forest, botanical inventory data;

d. Capacity for effective and efficient maintenance of monitoring system, including computers, GPS, GIS, other relevant tools and human resources;

e. Standard maps at a scale of 1:25,000 for the whole country using GIS data, indicating different forest zones, forest boundaries, forest cover classes, wildlife sanctuaries and important habitats for rare and endangers wild animals and other critical biodiversity conservation considerations.

4.2 Specific Activities

ix. The inventory units must be mappable from polygons that are discernable oil imagery

xiii. The results should be analyzed, maintained and presented in the form of a GIS and geo-reference database linked specifically to other inventories,

Work Plan Milestones

Standard maps for the whole country

Forest reserves boundary survey

A major concern has been the problems in contract negotiations with the candidate for Principle Surveyor proposed in the project tender proposal. Negotiations began in July, and proceeded until December, when the negotiations broke down. As a result this component of the project is far behind schedule. BIT has been informed on the situation regarding the contract negotiations.

As it has not been possible to commence the survey as planned this has lead to a new approach being considered. At the close of the reporting period discussions were being held between FCG and BIT over the adoption of a revised approach.

The revised approach would be to could follow the model of the PROUD Project. The PROUD (Programme for the Rationalization of Unplanned Development) project faced a similar situation on surveying a large number of parcels which required titles. The Ministry of Communication, Works, Transport and Public Utilities compiled a list of all parcels, and allocated them to surveyors through a process of advertising and direct approach. This allowed the work to be completed on time, and provided an element of open competition which helped keeping the costs within the budget limits.

In the PROUD Project there was no need to survey all the boundary points, in the case of existing boundaries. Provided the boundaries were cleared and existing points identified, there was only a need to resurvey missing markers, and markers which appeared to have an error.

The following approach to the boundary survey component is proposed to be followed in the project:

1. Existing boundaries
    a. Clearance of existing boundaries by FD and project staff
    b. Identification of existing survey points through the use of GPS
    c. Contracting out survey of those points which need to be resurveyed
2. New parcels (new land addition)
    a. Compilation of a list of new land groupings
    b. Prepare a list of areas to be added in descending order of size
    c. Contracting out of survey additions in groups as ordered above

The advantages of the proposed approach are that the survey can be initiated in a relatively short period of time, that the parallel work allows the easier achievement of the deadline, and that the risk for delays is smaller as no individual surveyor can control the whole process. The approach also offers a clear way ahead with a clearly structured work plan. On the other side, the disadvantage is that it is difficult to estimate the costs in advance. The approach also requires more administrative work from the project staff.

Discussions concerning the revised approach were continuing at the close of the reporting period.

Appointment of ancillary project staff

During the period of this report the project's non-key experts and field workers were recruited.

Non-key experts

Four on-key experts were appointed to the project after a review process carried out by the Conservation Biologist in association with the Project Leader. The following non-key experts were appointed after approval by the BIT.

Botanist

Roger Graveson

A British trained botanist Mr. Graveson has studied the forests of St Lucia for over 20 years, and has a thought understanding of the different forest types. He has worked with the FD for many years and is well known to the Department. He will contribute to the project for a period of four months starting in January.

Mr. Graveson's CV can be seen in Annex 8 below.

Habitats Specialist

Matthew Morton

Mr. Morton is well known to the FD, being the Eastern Caribbean Manager of the Durrell Wildlife Conservation Trust. He brings Durrell's considerable experience and knowledge to the project. Mr. Morton will contribute 2 months to the project and assist the Project Leader in coordination of the Bioresource survey during the periods the Conservation Biologist is off island.

Mr. Morton's CV can be seen in Annex 9 below.

Mammalogist

Frank Clarke

Dr. Clarke is UK-based, but has worked in the Caribbean with experience in the Lesser Antilles. He will commence work in St Lucia January 11th for a period of three months.

An abridged version of Dr. Clarke's CV can be seen in Annex 10 below.

Entomologist

Mike Ivie

Professor Ivie is based at University of Michigan, and will travel to St Lucia to work on the project at no salary. He will bring a team of graduate students who ~~e~~he will supervise in entomological studies for a period of three months.

An abridged version of Professor Ivie's CV can be seen in Annex 11 below.

Inventory field workers

Three field workers have been selected for employment in the inventory field work. They include two unemployed men and a member of the St Lucia Fire Service.

All three prospective field workers were part of a group of 9 individuals, 3 women and 6 men, who applied for work with the project. The applicants were recruited through publicity generated via radio and television broadcasts, as well as word of mouth. All of the applicants took part in the forest timber inventory training course, with eight finishing the course, and one dropping out after the first day.

All applicants who took part in the entire course were rated on their achievements in the training course, and their prowess in the field exercise. The top three applicants were invited to attend the subsequent Bioresource training course, and all three chose to attend. All three performed very well and made a significant contribution to the training course.

Due a Government desire to increase employment, the two unemployed men were offered positions in the field team, which both accepted. The Fire Service was approached with a request to second the serving fireman, who had been the highest scoring attendee in the timbered inventory training course.

Other Project activities

Meetings

The Project Leader attended numerous informal meetings with BIT, FD, and other stakeholders to coordinate project activities. Project committee meetings were held as shown below.

Project Implementation Unit

Inaugural meeting, November 12th, 2008

Project Technical committee

Inaugural meeting, December 15th, 2008

Key Experts visits to support the project

Over the last five months there have been four visits to St Lucia by Key Experts. Three short visits were made by the project Conservation Biologist, Dr. Jenny Daltry, to conduct a training needs assessment, recruit non-key experts, plan the Bioresource survey, and to provide training in Bioresource assessment. One 5 week visit was made by the project GIS and Data Management Specialist, Mr Vijay Datadin, to establish the GIS system and to commence preparation of maps. Further details of the work produced during these visits are contained above.

Annexes

The following annexes are included below.

Annex 1 Timber inventory training manual outline

1. **Basic Forest Mensuration**
    - 1.1. Introduction
    - 1.2. Tree Measurement
        - 1.2.1. Count
        - 1.2.2. Species
        - 1.2.3. Diameter
        - 1.2.4. Height
            - 1.2.4.1. Measuring heights with the Suunto PM-5
            - 1.2.4.2. Direct height measurement
            - 1.2.4.3. Indirect height measurement
    - 1.3. Bark Thickness
    - 1.4. Log Measurement
    - 1.5. Diameter
    - 1.6. Length
    - 1.7. Weight
    - 1.8. Area Measurement
        - 1.8.1. Plot shape and size
        - 1.8.2. Slope correction
    - 1.9. Use of a GPS (Geographic Positioning System)
        - 1.9.1. GPS basics
        - 1.9.2. GPS configuration
        - 1.9.3. GPS use
2. **Tropical Rainforest Inventory**
    - 2.1. Introduction
    - 2.2. Objectives
    - 2.3. What to measure
    - 2.4. Integration
    - 2.5. Stratification
    - 2.6. Field plots
        - 2.6.1. Plot types
        - 2.6.2. Inventory plot layout
        - 2.6.3. Attribute sampling
        - 2.6.4. Field plot measurement
    - 2.7. Random sampling design
    - 2.8. Systematic sampling design
    - 2.9. Calculations
    - 2.10. Computer systems for processing field data
    - 2.11. Integration
    - 2.12. Remote sensing
    - 2.13. Geographical information systems
    - 2.14. Complete systems integration
    - 2.15. People

Annex 2 Biodiversity survey training course outline

Day 1

09.00 – 09.45 **Introduction**
- This project: what it is for, what will happen.
- Purpose of this workshop
- Why do research?

9.45 – 11.00 **Forests and Forest Wildlife on St Lucia**
- Introduction to Tropical Forests (different forest types on St Lucia).
- Forest Biodiversity (what biodiversity means, forest animal and plants on St Lucia, conservation values, food webs)

11.00 – 12.00 **Map Reading**
- Types of maps
- Contours and symbols
- Using map coordinates
- Mapping exercise

13.00 – 14.00 **Surveying Forest Species – Part 1**
- What do we need to know?
- Naming species (common and scientific names)
- Distribution (mapping distribution; sources of information)

14.00 - 15.00 **Interview techniques**
- Interview design: open versus closed questions
- Avoiding bias
- Analysis
- Interview role play and exercise

15.00 **Wrap up and end.**

Day 2

09.00 – 11.30 **Surveying Forest Animals – Part 2**
- Introduction
- Sampling (non systematic sampling and systematic sampling with quadrats, transects, points).
- Abundance (different ways to measure abundance; absolute versus relative abundance; mark-recapture exercise)

11.30 – 12.00 **Recording Information**
- Notebook management
- What to do with the data
- Priority species to record

13.00 – 14.00 **Navigation**
- How to navigate with a compass (bearing and back-bearings)
- Use of GPS
- Altimeters
- Route planning exercise.

14.00 – 15.00 **Field Craft and Safety**

15.00 **Prepare for next day, and end**

Day 3

08.00 - 12.00 **Field practical exercise in Union forest grounds.**

Annex 3 Timber Inventory design

This section contains the main details of the timber inventory design. The design will be refined during the initial days of the implementation of the inventory.

Objectives

The objectives of the project include the following statement from the project Terms of Reference.

> To conduct a comprehensive biophysical inventory/assessment and management system of forest resources to produce, inter alia, a forest resource monitoring system; obtained through ground survey, remote sensing, assessment and review of existing data that will serve as the basis for strategic sustainable planning and management of forest resources.

The objectives of the timber resources inventory are to quantify the amount of timber available in the forest resources of St Lucia. This is to complement the details to be collected in the biophysical biodiversity resource inventory.

Previous Inventory

A previous inventory was conducted in 1982. (Piitz, 1983). Two volumes of inventory results and calculations were prepared, but only Volume 1, containing the main inventory design features and main results, is currently available. The inventory had the following inventory characteristics.

1982 Inventory characteristics	
Strip interval	400
Nominal plots size	0.1
Sampling intensity	1.8%
Approx. no. Plots measured	1089
Area inventoried	6002
Area sampled	108.9
Total area of forest	6781

Table 1 1982 inventory characteristics

The following forest management classes were defined for the 1982 inventory.

Forest Management Class	Description
Exploitation forest	Areas of forest with slope less than 30 degrees not requiring protection for other values
Protection/Production forest	Areas of forest with slopes less than 30 degrees requiring protection for other values, while allowing limited production
Protection forest	Areas of forest with slope greater than 30 degrees and any other areas requiring protection

Table 2 Forest management classes

The inventory was based on strip plots established at approximately 400m internals, and returned the following estimates of total wood volume in St Lucia

Administrative Unit	Forest management class Exploitation	Protection/Production	Protection	Total
Northern Range	0.8	106.7	30.0	137.5
Millet Range	0.0	31.3	234.0	265.3
Dennery Range	89.8	15.7	177.9	283.4
Soufriere Range	0.0	62.0	218.3	280.3
Quillesse Range	46.0	97.0	163.0	306.0
All ranges	**136.6**	**312.7**	**823.2**	**1272.5**

Table 3 Total Volume on Forest Land by Management class and administrative unit (,000 cubic metres)

The inventory included estimates of the inventory accuracy, which were calculated to give a standard error of estimate of 2.4% and a coefficient of variation of 8.1% for the overall forest estimated mean volume of 189 cubic metres per hectare. However the calculations used did not accurately reflect the error in volume estimation, approximately 14% on average, which means that the true error in the estimation of total volume was most likely around 10%.

Inventory Design

The inventory design will be based on a stratified randomized strip model.

Stratification is the process of dividing a population to be sampled into groups of similar sampling units, based on population characteristics. In the case of the forest timber inventory, the population characteristics are a combination of management characteristics and biological characteristics.

The forest will be divided into 15 initial strata based on their range administrative unit, and within ranges based on their forest management class. Then within each management class the individual watersheds will be classified on their broad biological classification.

This will produced a list of identified units to be sampled, to be termed ***forest units***. Each forest unit will have a determined area, and will be identified by the above three-way classification.

The principles of random sampling dictate that each sampling unit has an identified probability of being sampled, with the probability being equal within a stratum. Individual stratum may have differing sampling intensities, reflection differing managerial importance. However, within each stratum, each area of forest must have the same probability of selection as a sampling unit.

The probability of sampling will be reflected in the sample design within each stratum. Strata will be sampled with randomized sample plots located on systematically established gridlines. The procedure will be to identify the start of a strip line, and then establish sampling units at randomized intervals along the strip line. This will be done by locating the first sampling unit, measuring the sampling unit, and then preceding along the strip line a randomly determined interval.

The sampling units will be strip plots, located on either side of the strip line, 5m from the centre of the strip line. Each strip plot will be a predetermined length, with the length varying between strata. The lengths will vary from a 50 metre minimum to a 100 metre maximum. Each sampling unit will be sized to ensure that an average of at least 20 trees is measured within each sampling unit within each stratum.

Definition of forest units

Forest units will be defined using the GIS system. Administrative boundaries will be identified, followed by forest management classes. The intersection of these boundaries with watershed boundaries will be formed, as well as a vegetative mapping of the forest based on available vegetative information. This vegetative mapping will be established using input from the conservation biologist.

A further division will be slope class. Slope class is incorporated into the management classes as shown above. The GIS will be used to define areas of slope which will be incorporated into the definition of forest units.

The above boundary sets will be used to define the forest units. The GIS system will be used to define a list of forest units in each stratum with the area of each forest unit. There are likely to be numerous fragmental forest units, with areas of some forest units likely to fall under 1 hectare. When the areas of all forest units are known, a lower limit for systematic sampling will be defined. This lower limit is anticipated to be 10 hectares, but will be define so that approximately 80% of the total forest area is above the limit.

For those forest units above the lower size limit, systematic sampling will be used. A systematic grid will be overlaid on each forest unit and gridlines established. Random internals on the grid lines will be established either with the aid of the GIS, through a specialist routine, or in the field during gridline measurement.

The approximately 20% of forest units falling below the lower size limit will be sampled using random sampling, with the sample intensity reflecting the stratum intensity, as indicated in Table 4 below.

Area estimation

Areas will be calculated from the GIS using internal GIS procedures. Theses area estimates will be used in the inventory of consistence. At a later stage boundary information will be available from the survey boundary. These more accurate data will be used to update the area estimates in the GIS and will be supplied to the FMIS.

GIS Mapping and area estimation

The project will put an emphasis on strengthening the GIS capacities of the FD. The latest version of Arc View has been purchased, along with a quad-core PC with 640 Gb of hard disk space. This system will be configured by the project GIS expert. All available map information will be installed and configured on the new GIS system. Additional satellite imagery will be purchased and used to update the system.

The areas of all forest units will be calculated using the new system. These areas will be adjusted during the process of the inventory to ensure that the forest classifications are as accurate as possible. The process of updating stratum areas will continue during the inventory analysis stage.

Slope classes

The GIS system will be used to update slope classes through the use of DTM technology. This will provide a more précised slope mapping of the forest areas of St Lucia. The accuracy of this mapping will depend on the accuracy of imagery available.

Sampling intensity

The sampling intensity will vary based on the stratification. Target sampling intensities will initially be set as shown below. Sampling intensities will be varied by increasing the distance between gridlines and the interval between sampling units along grid lines.

Forest Management Class	Gridline interval	Plot size	Sampling intensity
Exploitation forest	300	.07	2.1%
Protection/Production forest	500	.07	1.0%
Protection forest	750	.05	0.3%

Table 4 Sampling intensity

The size of individual forest units may preclude strip sampling. In such cases random sampling will be utilized.

Data to be recorded

The main information to be recorded in the timber inventory sampling units will be the species and diameter at breast height of all trees over 5 cm dbh. Tree heights will not be recorded in field plots. The presence or absence of specific items will be recorded to enable attribute sampling information to be collected. This will enable information to be collected on NTFPs.

The NTFP attributes to be sampled will include the following variables, in which presence or absence within the plot or surrounding area will be recorded.

1. Snake
2. Incense
3. Others to be selected to a total of 9 attributes

Volume

The volume of trees in the inventory will be calculated using volume functions developed during the 1982 forest inventory. The volume of tropical trees is difficult to estimate without the destructive sampling of large numbers of trees. For the purposes of this inventory the well established relationship between the diameter of a tree and its' volume will be relied on. The 1982 inventory produced six local volume functions based on data recorded from 318 trees. The techniques used were not those that would be used in 2008, but inspection of the graphs shown in Appendix B Volume Equations of the 1982 inventory report show an acceptable fit for all six equations. Efforts to locate the original data were unsuccessful, and so a decision was made that the volume functions would be used in the form recorded in the 1982 inventory.

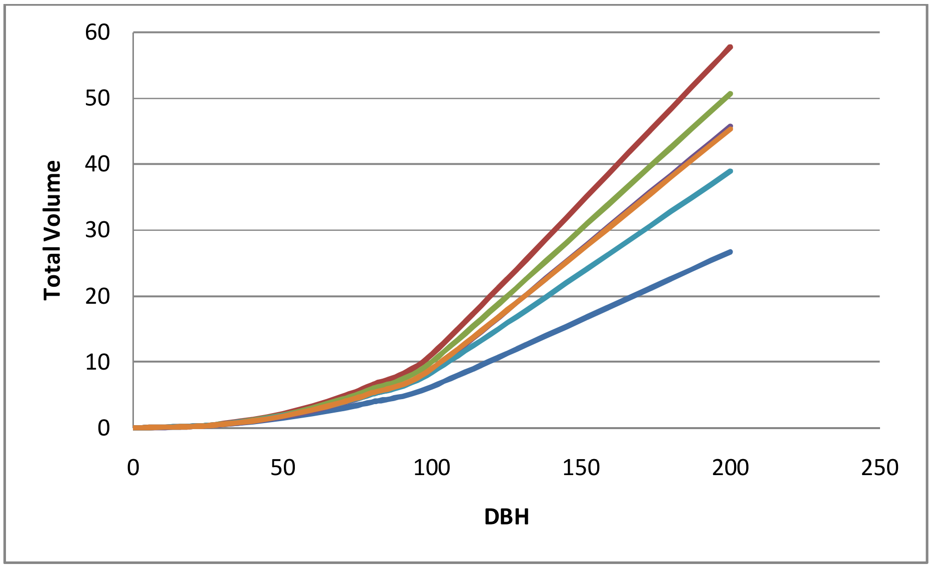


Figure 1 Total volume on dbh by species group

Crown class

During the 1982 inventory crown class was recorded. Crown class will not be recorded in this inventory, as there is a separate biological inventory, which is collecting information on forest structure. The biological inventory will provide information on forest structure including crown class.

Quality assessment

The 1982 inventory included the estimation of the quality of trees from the timber production perspective. Each tree was classified into Quality class A, suitable for saw log production, and Quality class B, not suitable for saw log production.

The inventory results included the division of total and merchantable volume into the two classes, A and B. The results showed approximately 70% of the total volume was in class A, and 30 % in class B.

These classes are obviously subjectively defined, and the use of such classes would lead to problems in ensuring that the quality classes were being assigned correctly by all inventory team members. Moreover, saw log production is not the only use for standing trees, and improvements in processing since 1982 have provided methodologies whereby a greater percentage of a standing tree can be processed.

Given the difficulties in defining objective quality classes, and the relative low value of the information that can be provided, quality class information will not be collected in the inventory sample plots.1

Field procedures

The inventory will be conducted by teams composed of a team leader who will be a FD staff member, supported by two forest technicians, one a local range FD staff member, and one a project hiree, with two cutlass men providing assistance. Two teams will be fielded. The teams will move

1 This does not apply to permanent sample plots, in which quality as well as crown class information may be collected.

throughout St Lucia, and efforts will be made to maintain a consistent team structure to encourage team motivation.

The two teams will initially operate as one to ensure that standard procedures are used by both teams. Only two cutlass men will be engaged during this initial period, anticipated to be the first week of operations.

Field procedures will be as follows.

1. The field team will travel to the location of the gridline to be sampled, having a specialised map in their procession
2. The team will then proceed to the point the gridline starts, and then proceed along the gridline to the point where the first plot is to be located, using compass and GPS.
3. The starting point of the plot will be recorded using the GPS if the position can be so recorded. The plot position should not be relocated to a point providing a better GPS reading.
4. The first plot will be located by establishing the central line, and measuring all trees above 10 cm in dbh within 5 metres of the central line. Trees entered into pre-printed plot sheets numbered sequentially.
5. For each tree the dbh and species will be recorded.
6. All trees within the pre-determined plot length are to be recorded. The plot size shall remain as pre-determined, even if the plot has a low number of trees, and even if the plot has no trees.
7. Attribute data shall be recorded as pre-determined.
8. The team leader may make such comments as are felt required on the back of the plot sheet. Any unusual incidents or observations should be recorded and noted to the Project Leader on return.
9. After measuring the plot the team shall proceed along the gridline the pre-determined random distance before establishing the next sample plot.
10. After the gridline has been measured the team should proceed to the next gridline
11. The team leader should make any decision as to when the team returns to the vehicle or terminates the day's work. All safety guidelines are to be strictly enforced.
12. The team leader is responsible for protection of completed plot sheets, which should be stored in a waterproof location, and which should be returned to the project office as soon as possible.

Processing of inventory results

All inventory measurements will be recorded on a standard form, and will be processed by the FMIS under development. The system will store all plot measurements, to enable tree distribution tables to be prepared. Individual tree diameters and species will be stored. Volumes will be calculated using the volume functions prepared for the 1992 inventory,

Statistical calculations will be done at the diameter or basal area level, as volume will be a derived variable. As such, error calculations will be available for stocking and basal area, but not volume. Volume error estimates can be expected to reflect the basal area estimates, given that the volume estimates will have a larger error due to the error of volume prediction.

The FMIS will be able to provide estimates at the forest unit level, watershed level, stratum level, forest management division (range) level, and national level. Estimates at all levels will have a valid error of estimate.

Sampling order of priority

A specified order of priority will be established to control the inventory sampling. The initial sampling will be conducted in the areas nearest to the Forestry Department headquarters. The less remote areas will be sampled first to enable procedures to be developed, and to fine tune the inventory data collection routines. The initial sample plot data will be transferred to the FD headquarters on a daily basis, so that the data can be examined for any inconsistencies or inefficiencies. This will allow the inventory design to be modified rabidly to ensure that the most efficient design is established.

The subsequent sampling will move further from the FD headquarters following the priority shown below. This priority will be adjusted as necessary to ensure effective sampling.

AREA	Hectares	Order
Castries	1393	1
Barre-de-l'Isle North	231	2
Barre-de-l'Isle South	724	3
Dennery	145	4
Dennery Ridge	71	5
Addition Central	121	6
Central B	1474	7
Quilesse	1400	8
Saltibus Grand Magasin	107	9
Central A	1631	10
Marquis I	134	11
Marquis 2	35	12
Marquis 3-6	19	13
Forestiere Blocks 1-5	12	14

Permanent sample plots

During the course of the project a series of permanent sample plots will be established to enhance the existing permanent sample plots. The design of the permanent sample plots will be consistent with the design of the existing sample plots, but may differ. The design of the permanent sample plots will be released in April 2009, to enable experience obtained during the early inventory data collection to be used in the design. Permanent sample plots will be established during 2009, but initial priority will be given to the timber resource inventory to ensure the inventory data are collected. The inventory period will run from January 2009 to June 2009. The establishment of psps may continue outside this period.

References

Piitz, P.O., 1983. Forest Inventory Report, St. Lucia-CIDA Forest Management Assistance Project, Volume 1. , May, 1983

Annex 4 Draft timber inventory activities

Introduction

This document outlines in broad details the recurrent activities to be carried out during the St Lucia Forest Inventory. The process of inventory is cyclic and ongoing, consisting of a repeated process of redefining the forest into more specific detail. This is achieved by a gradual refining of the forest stratification described in steps 1 and 2, followed by further sampling, and repeated analysis.

Further precise detail is to be found in two supporting documents to be produced, the St Lucia Forest Service Inventory Guide, and the St Lucia Forest Service Forest Management Information System User Guide, further referred to as the Inventory guide and the SLFMIS guide respectively.

1. Forest typing

The first step in forest inventory is to develop forest type maps. This involves the delineation of areas occupied by forest on a map, either manually or digital, using either colour shaded maps or a GIS software package. These areas are known as forest units.

The forest typing should identify the forest in terms of the location of the forest unit, the area of the forest unit, the managerial classification of the forest unit, and the species composition of the forest unit.

The typing may be broad or narrow, depending on the resources available. The typing can be extended at a later date, to allow more refined inventory results to be calculated. The more narrow the typing, the more sensitive the inventory.

It is vital that the area of each forest unit is measured. The overall accuracy of the inventory estimates depends on the area measurement and the accuracy of the forest statistics calculated.

If the forest units are identified using tracing paper in the first instance, they should be digitised into the GIS at a later stage, and the area estimates updated.

2. Identify forest strata

The second step is to divide the forest units into forest strata. A forest stratum is a collection of similar forest units, which will be managed together.

From a forest manager’s point of view, stratification gives information on management units, which the manager can use for management decision making. A forest manager may divide his forest into productive and non-productive forest, putting most of his managerial efforts into the productive forest. The forest manager gains a better understanding of his forest through the use of a carefully thought out forest stratification.

The forest stratum is the inventory component that provides estimates of forest statistics. No estimates of forest statistics are available for any lower level inventory components. A forest unit, for example, does not provide any estimates of forest statistics.

The forest units identified above should be classified into forest strata. All forest units must be included in a forest stratum for the inventory results to be accurate.

3. Enter forest units in SLFMIS

The details of the forest units should be entered into the SLFMIS, with their strata definitions. This step is vital to classify the inventory to ensure that inventory results are as sensitive as possible.

The information entered in the SLFMIS will allow the forest manager to understand the nature of his forest.

4. Sample plot distribution

Most forest inventories use systematic sampling. Systematic sampling is sampling on a grid imposed over a forest. An example would be using the geo-reference grid found on many maps as a guide for sampling.

Systematic sampling can introduce bias, if there is a systematic pattern in the forest being sampled, such as a regular series of ridges and valleys. Any sampling scheme that had sample lines following a ridge or valley pattern would be likely to produce biased estimates.

In St Lucia systematic sampling is unlikely to introduce bias, due to the nature of the geography of the island.

It is important that any systematic sampling grid be established objectively. A grid line should be defined in such a manner that bias is avoided. An objective starting point should be determined.

For the forest inventory in St Lucia, sampling should be carried out by placing sample points on a gridline at intervals as defined in the inventory design document over the forest units.

A sample plot should be located at the intersection of each grid line. The access to the forest unit should be considered, to ensure that field team safety is protected.

5. Establish sample plot

Field sample points should be established at each grid point location. The sample point should be either a sample plot, or a strip plot, depending on the nature of the forest.

The field team should travel to the sample point via a compass bearing from a suitable access point, such as a road.

The measurements to be collected within the sample plot are the species and diameters of all trees.

6. Measure sample plot

The diameter of a tree is the single most important measurement that can be taken from a tree. Tree diameter is closely related to tree height and volume. Accurately measured tree diameters can allow a forest manager to estimate forest volume with a reasonable degree of accuracy.

The diameter of each tree over 5 cm should be measured in centimetres to one decimal point with a diameter tape at a point 1.3 m from the base of the tree, measured on the uphill side of the tree

7. Enter sample plot information

The sample plot information should next be entered into the SLFMIS computer system, after careful checking for transcribing errors, punch errors, and obviously bad measurement errors. It is vital that all data entered have been collected accurately, and recorded correctly.

If the data are not entered correctly, the inventory results will not be accurate.

8. Check sample plot information

The SLFMIS Plot details report should be run for each plot after data entry. This report lists any errors that can be found, such as zero dbh, suspect heights, low height diameter regression r2 values, and zero plot areas.

The printouts from the SLFMIS should be compared with the field data sheets. Any incorrect or bad data should be corrected in the SLFMIS or removed from the database.

9. Examine stratum reports

After each batch of plots has been entered into the SLFMIS, the stratum summary reports should be run.

The reports present the inventory summary details for examination. These reports show see how accurate the inventory is, so that a decision can be made whether to carry out more sampling.

The examination of the summary reports will show the degree of accuracy that has been achieved in the inventory. This is the PLE of the basal area estimate.

If the PLE is too high, over 10%, this indicates that either the sample intensity is too small, or that the stratum is too varied.

If the PLE is too high, either more plots need to be measured each forest unit, or the forest units need to be divided into smaller units with less variation within them.

10. Redefine forest units as necessary

If the stratum reports show that the strata are too large or poorly defined, it is necessary to redefine the forest units into more homogenous groupings, or subdivide the forest units.

This is done by remapping the forest units into smaller units, and allocating them to different strata. New strata should be defined to allow variation between strata to be excluded from the PLE estimate. After redefining the forest units, the analysis is repeated, and the process recommenced.

Annex 5 Draft timber inventory guide

Introduction

This manual is a guide to conducting forest inventory for use by the St Lucia Forestry Department. It does not contain all the theory and detail necessary to fully understand forest inventory. It is intended to provide a general guide on conducting inventory, identifying aspects of forest inventory that should be considered.

The guide is designed to supplement training inventory team members have already received. The guide should serve as a reminder of important aspects of forest inventory.

The guide does not include details on the analysis of forest inventory data. These are contained in the guide to the St Lucia Forest Management Information System, which contains an inventory data analysis module .

Those involved in the preparation of a forest inventory should obtain comprehensive texts on the subject of inventory, and make a full study. A list of suitable texts is given in the Recommended Reading section of this guide.

Statistical terms in forest inventory

A forest inventory is a process of statistical estimation. It is worth reviewing a number of statistical terms that apply in forest inventory, as in any statistical sample.

Random

All statistical samples should be taken at random. A random sample is defined as:

"A sample of n units selected from a population such that each possible combination of n has an equal likelihood of being selected."

For forest inventory, this means that every point in a forest unit must have an equal chance of being selected.

Bias

Random sampling is designed to prevent bias. Bias is defined as:

"A systematic distortion of an estimate"

A biased estimate is an estimate that is systematically different from the true value. An example of bias would be measuring diameters with a tape that had lost the first 2 centimetres. All the diameter measurements would be 2 cm greater than the trees in question.

Accuracy

Forest inventories are designed to provide accurate estimates. Accuracy is defined as:

> "The closeness of an estimate to the true value"

For a forest with a true average diameter of 45 cm, an estimated mean diameter of 44 cm would be accurate, and an estimated mean diameter of 55 cm would be inaccurate.

Precision

Precision is defined as:

"The closeness of sample values to their true mean"

In the case above, an inventory with sample diameter estimates of 43, 44, 45, 42, and 46 would be precise, whereas one with sample diameter estimates of 42, 46, 40, 48, 38 and 50 would be imprecise.

Probable Limit of Error

The accuracy of a forest inventory is often expressed in terms of the probable limit of error, or PLE. This is the 95% confidence limit of the mean, expressed as a percentage.

Accuracy of inventory

The St Lucia forest inventory is aimed at estimating the combined basal area of a stratum to the ±10% level at a 95% probable limit of error. The accuracy of the stocking per hectare figures will be calculated from the sampling intensity level of the basal area estimate.

Estimates of volume can only be tentative, as there are no existing tree volume tables for St Lucia. The St Lucia Forestry Department uses a log volume table for estimating tree volume. The log volume table applies to all species, and is a simple form factor table. Such a table can provide indicative volumes only, and does not allow for accurate estimates of stand volume. As such no accurate error terms can be allocated.

The accuracy of the inventory will be highly dependent on the success in dividing the forest into small homogeneous forest units. If the forest units are large, a high sampling intensity will be necessary to achieve the aimed degree of accuracy.

Forest typing

The first step in forest inventory is to develop forest type maps. This involves the delineation of areas occupied by forest on a map, either manually or digital, using either colour shaded maps or a GIS software package. The areas so delineated are known as forest units.

The mapped forest units form the sampling frame for the inventory. The sampling frame is the reference framework for the inventory, setting out the areas to be sampled, and defining the extent of the forest.

The forest typing should identify the forest in terms of the location of the forest unit, the area of the forest unit, the managerial classification of the forest unit, and the species composition of the forest unit.

- Location
- Area
- Management class
- Species composition

The typing may be broad or narrow, depending on the resources available. The typing can be extended at a later date, to allow more refined inventory results to be calculated.

It is vital that the area of each forest unit is measured. The overall accuracy of the inventory estimates depends on the area measurement and the accuracy of the forest statistics calculated.

Once the forest units have been defined, the inventory can be carried out. It is possible for forest units to be defined after inventory has been carried out, but this is not the most efficient method of conduction forest inventory.

Stratification

Stratification is the procedure of dividing the forest up into collections of forest units that are of managerial interest. For example, a stratum could consist of all areas of forest that contain mature Casurina equisetifolia or all areas planted with Acacia nilotica for slope stabilisation. Another definition of a stratum could be all areas with a slope greater than 20 degrees.

Reasons to stratify

Statistical

The statistical reason for stratification is to increase the between strata variance. This means that by defining strata that contain very different types of forest, variation in forest types can be limited to variation within similar forest types.

A farming example would be to measure the average weight of pigs and chickens separately, rather than the combined average weight, which is of no realistic interest. In this case the farmer has stratified his livestock into pigs and chickens.

A more realistic example is to calculate the average weight of male versus female pigs.

Managerial

From a forest manager's point of view, stratification gives information on management units, which the manager can use for management decision making. A forest manager may divide his forest into productive and non-productive forest, putting most of his managerial efforts into the productive forest. The forest manager gains a better understanding of his forest through the use of a carefully thought out forest stratification.

The forest stratum is the inventory component that provides estimates of forest statistics. No estimates of forest statistics are available for any lower level inventory components. A forest unit, for example, does not provide any estimates of forest statistics.

Allocation of forest units

The actual implementation of the process of stratification is carried out by allocating the forest units into different strata. This can be done before or after the forest units have been sampled. The process is carried out by merely selecting which stratum the forest unit belongs in. In a computer program this could consist of selecting the appropriate stratum from a list.

Each forest unit can belong in only one stratum. The forest inventory will not give any estimates for the forest unit, unless a particular forest unit is defined as a stratum as well as a forest unit. For example, a very large area of a valuable timber species may be important enough to be defined as a stratum. In this case the stratum would have only one forest unit, and a high sampling intensity would be needed for that forest unit. Separate estimates of the forest unit's forest statistics would be produced.

Most strata will have more than one forest unit in them. The number of strata can be increased as the inventory proceeds, by reallocating forest units to different strata that are defined during the inventory.

Sample intensity

When an inventory is carried out, different sampling intensities can be carried out for different forest strata. The sampling intensity is the number of sample points measured in a stratum expressed as a percentage of the total area of the stratum.

The sampling intensity used in an inventory depends on a number of factors, including the following.

- Value of forest
- Cost of sampling
- Variation of forest
- Future management objectives

All forest inventories are carried out with a limited amount of funding, and as such the wise forest manager will allocate a higher proportion of his resources to the most valuable of his forests. The cost of establishing a sample point may vary between different regions in the forest, and will need to be taken into account in calculating the sample intensity.

Variation within the forest will affect the sample size. If a forest is not divided into enough strata, the inventory estimates will be less accurate. A manager may decide to allocate a smaller sample size to a stratum that contains a number of less important forest units, and a higher sample size to a stratum that contains more important forest units.

There are statistical methods of calculating the number of sample points needed to achieve a desired level of statistical accuracy. All these methods require some prior knowledge of forest variation, which is often not available. The estimates are not particularly accurate, and act as a guide only.

With the use of a FMIS , the necessity to have prior estimates of sample intensity can be avoided. The inventory can be initiated with a subjective estimate of the number of sample points required. An estimate of accuracy cannot be calculated with less that 3 sample points, and will be inaccurate with less that 10 sample points. As such, inventory can be initiated with the initial aim of collecting at least 10 sample points in each stratum. After this initial data has been input into the FMIS, the FMIS will calculate the stratum estimates, along with their accuracy, allowing the forest manager to decide whether he needs increased accuracy or not.

Sample plot location

A forest inventory is a statistical sample of the forest, intended to give unbiased and accurate estimates of forest statistics. As such, the location of sample plots is critical.

Sample plots should be located randomly within the forest unit to be sampled. In theory, the sampling design should ensure that all parts of the forest are equally likely to be sampled.

In practice this is difficult in forest inventory. Problems of access often make it extremely difficult to sample certain parts of the forest. Locating a specific part of the forest can be difficult for reasons of navigation. Some steep areas of a forest may be too dangerous to sample.

Systematic sampling

For these and other reasons most forest inventories use systematic sampling. Systematic sampling is sampling on a grid imposed over a forest. An example would be using the geo-reference grid found on many maps as a guide for sampling.

Systematic sampling can introduce bias, if there is a systematic pattern in the forest being sampled, such as a regular series of ridges and valleys. Any sampling scheme that had sample lines following a ridge or valley pattern would be likely to produce biased estimates.

In St Lucia systematic sampling is unlikely to introduce bias, due to the nature of the geography of the island.

It is important that any systematic sampling grid be established objectively. A grid line should be defined in such a manner that bias is avoided. An objective starting point should be determined.

For the forest inventory in St Lucia, sampling should be carried out by placing sample points on a gridline at random intervals averaging 100metres. The sample interval can be increased for large forest units, or decreased for small forest units.

Sample plot size

A further aspect of the inventor to be considered is the size of the sample unit, known as the sample plot in forest inventory. A sample plot may be of many different shapes, such as a square, rectangle, circle, hexagon, or even a star shape. In the case of the forest inventory in St Lucia a diamond plot shape has been selected.

A diamond plot is one in which a square plot is laid out on flat or sloping ground orientated up with its central axis running up and down the slope of the land the sample plot is established on. When theoretically projected horizontally, the square plot becomes a diamond shape. Diamond plots are simple to layout, and can easily be corrected for slope, as is necessary in sloping forest ground.

Aim for 30 trees

The size of the sample plot is determined by the stocking of the forest the sample plot is established in. A sample plot should sample enough of the forest to gain a representative estimate of the nature of the forest, but should not be so large as to waste valuable manpower resources.

For statistical purposes approximately 20 trees sampled constitutes a representative sample. Due to the varied nature of most forest areas, a sample plot cannot be guaranteed to have 20 trees in most cases. It is better to have slightly more trees than 20, rather than slightly less than 20. Hence the sample plot size should be set so that approximately 30 trees will be included. This represents a slight degree of over sampling, but not to a troublesome extent.

As an example, an inventory team leader is establishing sample plots in a forest unit that he estimates has 600 stems per hectare. He calculates as follows:

Sample size = 30/Stocking = 30/600 = .05 ha.

The inventory team leader knows he should use a .05 ha sample plot for this forest unit.

It should be noted that the same sample plot size should be used within any particular forest unit.

Study of previous inventories in St Lucia indicates that a sample plot size of .07 hectares should be used.

Diamond plot establishment

A diamond plot is easy to establish on the ground, one of the reasons to use diamond plots. Figure 1 shows the general layout of a diamond plot.

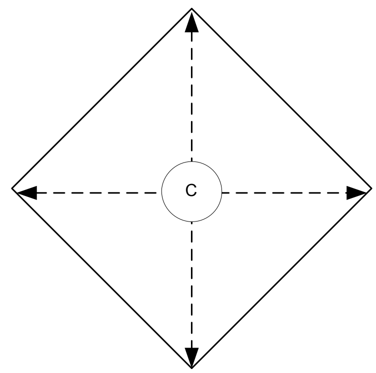


Figure 5. Diamond plot layout

Once the central point has been located, the sample plot centre should be marked with a peg. The slope should be measured both uphill and downhill, and the two measurements averaged to calculate the slope of the sample plot. The slope should be noted in the Comments section of the sample plot sheet. (See Appendix 3)

The slope should be measured with a hypsometer, such as a Suunto. Note that you should measure the slope to a point at your eye level.

Knowing the sample plot size and the slope, the length of the diagonal arm of the sample plot can be found in the table in Appendix 1.

For our example above, where the team leader has calculated he needs to use a sample plot size of .05 ha, Appendix 1 gives a diagonal area length of 15.8 m for flat land (slope 0), and 15.9 m for land with a slope of 10 degrees.

The diamond plot is laid out by measuring uphill the distance of the diagonal arm, 15.9 m for our example plot. At the 15.9 meter point a peg is hammered into the ground. Next a peg is placed 15.9 m downhill from the central peg. All three pegs should be sighted in line.

The final two pegs are laid out to the right of the central axis, and to the left of the central axis, at distances of 15.9 m and lined up on the central peg. This second axis should be at right angles to the central axis.

The resulting plot will occupy approximately 0.05 ha of land, adjusted for slope. If the two axes are not at right angles, a slight error in area will be made. This error is not great, and is self-correcting to a degree.

Once the sample plot has been laid out, all trees should be marked with spray paint marks to indicate that they are in or out. A tree is defined as being in the sample plot if more than half of it is inside the line between two corner pegs. There is no need to number the trees, as the sample plot is a temporary sample plot, which we do not plan to revisit, except possibly for checking purposes within a week or two.

The trees in the sample plot can now be measured, sector by sector. After the sample plot has been measured, the pegs can be removed for use at the next sample plot site. The centre point should be marked in some way, such as with a temporary peg made from forest material, or perhaps a cairn of stones, so that the sample plot can be relocated should that be necessary.

The measurements to be collected within the sample plot are the species and diameters of all trees, and a sample of tree heights.

Diameter measurement

The diameter of a tree is the single most important measurement that can be taken from a tree. Tree diameter is closely related to tree height and volume. Accurately measured tree diameters can allow a forest manager to estimate forest volume with a reasonable degree of accuracy.

The diameter of each tree should be measured in centimetres to one decimal point (e.g. "14.7") with a diameter tape at a point 1.3 m from the base of the tree, measured on the uphill side of the tree. This is defined as 'diameter breast height', or dbh.

It is sometimes necessary to move the measurement point up or down from 1.3 m to avoid unrepresentative measurements if there is a stem irregularity or significant stem buttress. It is better to make a true measurement than to attempt to make an averaged measurement, as averaged measurements are often calculated incorrectly.

Diameters should be recorded on the sample plot sheet to one decimal place, e.g. "11.3".

Height measurement

A sample of heights should be measured to enable the FMIS to calculate the mean top height of the stand. The MTH is calculated from a regression equation. The FMIS needs the heights of about 10 to 12 trees to calculate this height.

The sample tree heights should include three smaller trees, three average trees, and four to six trees at the top of the range. This is to ensure that the regression be can calculated accurately.

The team leader should be careful to ensure that only representative trees are measured. He should not measure short trees with large diameters, or tall trees with small diameters.

In mixed species stands a range of species should be included in the height tree sample.

The height should be measured with hypsometer. The instructions for measurement are as follows.

The height should be recorded on the sample plot sheet in metres to one decimal place, e.g. "11.2".

The hypsometer can also be used to collect other measurements which may be required, such as the length of the tree bole, or height to crown break.

Strip plot establishment

Some forest units may not be suited to the establishment of a diamond plot. These would include the following:

- Forest units with trees below 1.3m e.g. newly planted areas
- Forest units with non-forest species e.g. scrubland
- Dangerously steep areas
- Areas of low economic value
- Areas of natural forest with a high density and variety of trees.

In these areas a strip plot should be established. A strip plot is simply a plot running along the line of travel, where all trees within a fixed distance of the centre line are counted by species. Figure 2 shows the layout of a strip plot.

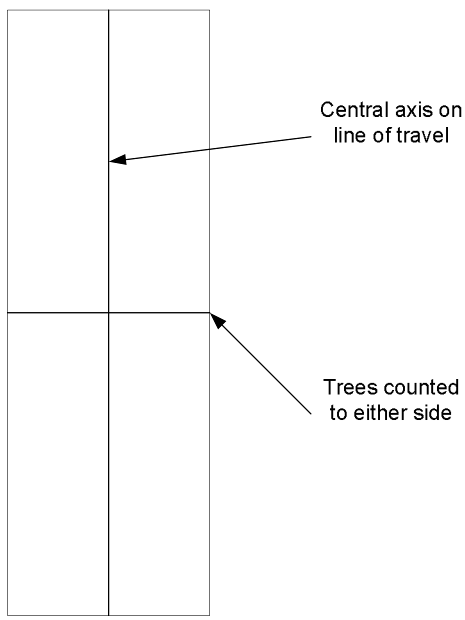


Figure 2 Example of strip plot. (Not to scale)

Strip plots should be put in in the direction of any slope, with the length adjusted for slope. Appendix 2 contains lengths and widths for a variety of strip plots at a range of slopes.

Appendix 3 includes a strip plot data sheet for your use.

Volume estimation

The volume of a tree may be measured directly, through the application of sectionally measurement techniques, or may be estimated from volume functions. In most cases tree volumes are estimated rather than measured, due to the considerable time necessary to collect the measurements required, and the frequent necessity to fell the tree to obtain accurate measurements.

Volume functions are derived from sectional measurements collected from a sample of fallen trees. The preparation of volume functions requires the collection of data from a large number of trees.

Separate volume functions are required for different species, and for differently managed trees of the same species.

The volume of a sample plot can be estimated either directly from the summation of the estimated volumes of the individual trees within the sample plot, or by indirect estimation from the sample plot estimates.

In the absence of tree volume functions for St Lucia forest species, the indirect estimation of plot volume will be applied to the St Lucia forest inventory.

Volume can be estimated using the following equation.

$V/B = a + bH$

where

V = stand volume per hectare

B = basal area per hectare

H = mean top height

a, b = coefficients

This general equation applies to a wide range of species. It is based on the volume of a cone, the simplest estimate of volume.

In the absence of St Lucia specific coefficients, values of 0.9 and 0.3 are used. These general values have been found to provide acceptable estimates of volume for a wide range of trees.

Conclusion

This guide to forest inventory has been produced as an aid to forest inventory in St Lucia. It contains all of the material necessary to conduct a forest inventory in St Lucia.

Further information can be found in the texts suggested below. A more full explanation for forest inventory sampling and statistical procedures can also be found in the various recommended texts.

This guide does not contain information on the analysis of the inventory data. This is described in the companion guide to the St Lucia Forest Management Information System.

No information on the collection of volume data has been included. At some future point volume functions may need to be developed for St Lucia forest species.

Armed with this guide and the RFMIS guide, St Lucia Forestry Department Staff will have the tools to carry out a successful forest inventory.

(References and Appendices omitted)

Annex 6 Health and safety guidelines

This annex contains the Health and Safety Guidelines as they were at 31/12/08. Some editing has been done to reduce the size.

Emergency Contacts

Project Contacts

You should attempt to contact one of these people, starting with the person at the top of the list and moving down the list until you succeed in passing on the message:

Project Leaders

Bob Tennent, Project Leader	Cell 716 3492; Office 468 5643; Home 458 4981
Adams Toussaint, Assistant Chief Forest Officer (Operations)	Cell: 716 0528; Office: ???; Home: ???

Other key personnel

Vijay Datadin, GIS Expert	Cell: ???; Office: ???; Home: ???
Jenny Daltry, Conservation Biologist	Cell: 723 7244; Office: 468 5643; Home: 452 0684 Overseas Cell: +33 632323248, Home: +33 563242768
Roger Graveson, Botanist	Cell: 715 6910; Office/ Home: 450 0765
Matt Morton, Habitats Specialist	Cell: 719 8966; Office/ Home: 453 4866
Insert other project members here	Cell: ???; Office: ???; Home: ???

Anias Verneuil (Dennery Range)
Alwin Dornelly (Quilesse Range)
David 'Stylo' Lewis (Northern Range)
Pius Haynes (Soufriere Range)

National Emergency Services

Police	**999**	**Hospitals**	
HQ, Castries	452 2854	Dennery	453 3310
Marine	452 2595	Golden Hope	452 2289
Crime Action Line	458 2880	Gros Islet Polyclinic	450 9661
Fire/ Ambulance	**911**	Soufriere	459 7258
Castries	452 2373	St Jude's	454 6041
Soufriere	459 7448	Tapion	459 2000
Vieux Fort	454 6339	Victoria	452 2421

Office for Disaster Preparedness (information on hurricane shelters)	452 3802
Helicopter	
St. Lucia Helicopters Ltd.	453-6950
Eastern Caribbean Helicopters	453-6952

Codes of Conduct

Individual responsibility

Every member of the project team must take reasonable care for their own health and safety, and protect other persons who may be affected by their actions or omissions.

All personnel should inform their team leader or line manager if they are unable to perform a task due to illness or if they lack the experience, equipment or confidence to operate safely.

Every individual is responsible for the safety of their colleagues. This includes being aware of the other individuals' capabilities and limitations, and warning them of hazards and dangerous activities.

All personnel should have medical insurance. A copy of the insurance card/ policy should be provided to the project office, together with other relevant medical details, including blood type, allergies, next-of-kin, and any essential medication needs.

No person is to drink, at any time, to the extent that they are unable to conduct themselves sensibly and safely. The possession and/or use of narcotics or other non-prescribed drugs are strictly forbidden.

Safety Code of Conduct

To ensure your safety and that of the whole survey party, all field workers are advised to adhere to the following code:

1. Every field team should carry a basic field first aid kit.
2. Every individual is advised to carry the following:
    - Whistle. Never use this whistle except in emergency. The international distress signal is SIX long blasts on the whistle every minute. (Blow numerous times to 'cancel' a distress signal). The correct response to the distress signal is THREE long blasts per minute.
    - Map, a compass and GPS.
    - Knife or machete.
    - Water and emergency food.
    - Telephone. Ensure it is fully charged and that all other team members know the number. You should not rely on the telephone to find a signal in all parts of St Lucia, however, especially ravines.
    - Flagging tape to mark trail.
    - At least one torch/ flashlight and spare batteries.
    - A firelighter.
3. Work in pairs or more (teams of three are recommended). Tell your team leader where you are going and when you expect to return. The relevant forest range office should also be notified in advance.
4. If you must leave a well-marked trail, mark your route by notching trees or with flagging tape so that you won't get lost, and to enable other people to follow you if necessary. Wherever possible, mark your route with a GPS and travel with guides with local knowledge on new, unmarked and difficult routes.

5. Always wear long trousers and hiking boots (leather is often recommended) in the forest. Many St Lucians favour the use of rubber knee-length (Wellington) boots over hiking boots. Flip-flops, sandals and soft shoes do not give sufficient protection against snakebite. A long-sleeve shirt will provide extra protection against biting insects. Snake guards, either knee-length gaiters or thigh-length chaps, are recommended in high risk areas.
6. Only personnel with appropriate training and experience should approach dangerous animals such as the St Lucia pit viper (fer-de-lance).
7. The field team should stop working before their weakest member becomes exhausted and at least one hour before darkness falls (unless working on a pre-arranged night survey).
8. Do not camp in areas liable to flooding (especially river beds) or landslides; near dead but standing trees, or under dead tree limbs; in exposed sites at risk from high winds or torrential rain; in areas infested with ants or termites; or beneath coconut palms.
9. Flammable and toxic chemicals, including fuel, should be clearly marked and kept in a safe place, well away from any sleeping or cooking areas in the house or field.
10. Take special care when using machetes, axes, knives etc., especially near other people. Store blades in their sheaths, if they have them, and do not leave them unguarded.

Environmental Code of Conduct

1. Nothing should be removed from the forest unless it is part of the survey or essential for your survival. Killing of any protected species (including snakes) is prohibited.
2. Minimise stress on wildlife: keep handling to a minimum and do not leave animals in traps or collecting vessels for longer than necessary. Use humane methods of euthanasia.
3. Do not over-collect specimens, especially potentially rare species. Any taking of specimens must be agreed to and permitted by the St Lucia Forestry Department in advance of collection, and any quotas stipulated adhered too.
4. To reduce the risk of forest fire, avoid smoking in the field, keep flammable liquids in marked containers, and ensure that any campfires are thoroughly extinguished after use.
5. There should be no sign of your camp or research area when you have left. All constructions should be dismantled, batteries and non-biodegradable litter taken back to town and disposed of carefully.
6. Never dispose of hazardous chemicals, such as formalin, in the field.
7. When working on private lands should take care to minimize damage to crops and keep livestock gates closed.

Hazards

Becoming lost

St Lucia is rugged and densely vegetated. It is very easy to become disoriented in the forest, even in areas you have visited before. It is inadvisable to venture off forest trails alone, especially without a good map, GPS and compass. Before going to the field, every team should agree a method of keeping members in contact (e.g., walking in single file and/or making regular contact calls).

All field workers should advise the project leaders of their planned itinerary every day, with clearly identified intended location(s) and intended departure and return times.

It is possible to survive several days without food, but not water. Remember that all palm shoots (heart) are edible; most bamboo heart is edible, though bitter; young shoots of most grasses are edible; the young leaves of plants are less toxic than older ones; it is safer to eat a little of several plant toxins than a large amount of one; and most animals are edible apart from the cane toad and certain invertebrates.

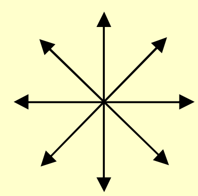
ACTIONS ON: BECOMING LOST

The person who is lost:

Stop

Retrace steps if possible

Try to locate trail/ routes using the star method: starting with 10m and working outwards, using a compass to walk on bearings and always returning to the centre of the star before walking the next arm of it. Leaving a note of where you've been and where you are going. Then moving out 20m in each direction, returning to the centre, and so on.



Remember to keep drinking water and taking breaks.

Do this until you figure out where you are.

If still lost go to top of closest ridge and contact search party. Try to telephone or radio your colleagues within your field team or, failing that, call the project leaders.

Do not use your whistle except in emergency. Use the international distress signal: **SIX long blasts on the whistle every minute**. (Blow numerous times to 'cancel' a distress signal).

Wait at top of closest ridge and blow 6 long blasts on whistle every minute until the search team arrive.

The other team members

Lost Rescue Coordination:

Take note of:

- Time of last contact with missing persons
- Number of missing persons
- Last known location
- Last known direction of movement

Notify the other teams of emergency and recall to assist with search.

Send search team to last known location to begin search.

Maintain contact with search team and continue to try and contact missing persons.

Be on standby to initiate medical rescue procedures.

N.B. Do Not try to initiate search at night or when light is failing

Lost rescue procedure:

Inform rescue coordinator of:

- Time of last contact with missing persons
- Number of missing persons
- Last known location
- Last known direction of movement

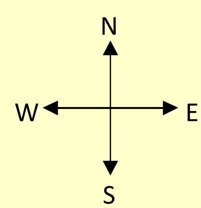
Assemble search team by access point i.e. by vehicle

Leave two persons by vehicle to advise if missing persons turn up and to act as information relay between search team and coordinator.

Search team advance to last known point of missing persons.

Initiate search:

Start by searching 10m North, then South, East and West systematically returning to central point each time. Continue this process for 20m 30m etc…



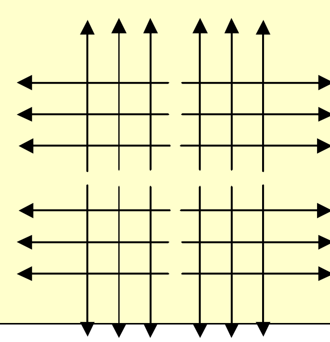
Then use 1 of 2 techniques:

With large numbers of searchers use the sweep technique:

Searchers form a line and all move in the same direction.

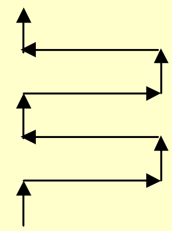
Each searcher should be in visual contact of the searchers on either side of them.

One searcher should be nominated to do 3 long whistle blasts every minute.



For smaller search team adopt the zigzag method:

The searchers move forward 3 paces, turn 90o and walk forward 10 paces; turn back 90o and walk forward 3 paces; repeat this pattern for each bearing.



Each searcher should be in visual contact of the searchers on either side of them.

One searcher should be nominated to do 3 long whistle blasts every minute.

Should missing person's distress signal (6 blasts) be heard respond with 2 long whistle blasts every minute and focus search in the direction of the whistle.

Once located the search team should notify the search coordinator via vehicle team if necessary. Include any information on physical/ mental condition to allow further resources assistance to be ready if required.

All persons should return to vehicle.

N.B. Searchers should allow time to get themselves out of forest before night fall.

Searchers should not put themselves under any unnecessary risk.

NOTE: We need potentially 4 triggers here:

1. What triggers the lost person to start calling/signalling for help? (Amount of time lost?)
2. What triggers the other team members to initiate a search? (Amount of time out of contact? or, obviously, hearing the distress signal)
3. What triggers the team to convene other teams in the forest to form a search party? (Amount of time spent searching by first team?)
4. What triggers the teams to call in outside assistance (Fire Service or Fire Service and additionally Police or Medical Services as appropriate)?

Injuries in the forest

These may include broken limbs, severe cuts and head injuries.

Cutlasses, or machetes, are among the greatest hazards to fieldworkers. Exercise extreme caution when using a cutlass: hold the handle firmly with a dry hand and direct the blow well away from your body, while ensuring that nobody else is standing nearby. Be careful of flying wood or thorns and never use a cutlass when tired or under the influence of alcohol. When sharpening a cutlass, always direct the file away from your body using well-controlled downward strokes. When not in use, the cutlass should be carefully stored to prevent anyone accidentally grasping or stepping on it. If you fall while carrying a cutlass, throw it away from your body (taking care not to throw it at anyone else!).

Other severe injuries can result from falls, and fieldworkers must take special care in areas with steep or unstable slopes. Climbing of cliffs or trees should not be undertaken without appropriate safety equipment and prior training.

All accidents and near-accidents to personnel must be reported to the Project Leader even if no injury or damage occurs, so that steps can be taken to prevent a recurrence.

ACTIONS ON: INJURIES IN THE FOREST

The person who is injured

Alert your colleagues immediately. If your colleagues are out of sight, use your telephone, radio or the international distress signal: SIX long blasts on the whistle every minute. It is best you sit still and let your colleagues come to your assistance.

The other team members

On hearing the distress signal, other survey participants should respond immediately (THREE long blasts of the whistle per minute) and decide the safest means of reaching the stricken individual.

With any casualty, the first priority is to ask him what happened. (This will tell you if he is conscious, his airway is clear and he is able to breathe). Check the following in order of priority:

1. ***Airway***: Check and ensure that the patient's airway is open and he can breathe.
2. ***Breathing***: If the airway is clear and the patient is not breathing, apply artificial (mouth-to-mouth) ventilation.
3. ***Circulation***: After the first two ventilations, check whether his blood is circulating by looking for a pulse. If there is no pulse, you should use external chest compression to help the heart pump blood around the patient's body, while continuing to apply artificial ventilation.
4. ***Recovery position***. If he is breathing and unconscious, put him in the recovery position to ensure that his airway remains open and unobstructed.
5. ***Control bleeding***: The other major and immediate threat to life is excessive blood loss. Apply direct pressure to the wound and, if possible, raise the affected part of the body. Also check for signs of other injuries.

If there are several casualties, treat them in order of these priorities.

If available, a helper should remain with each casualty to reassure him. Do not move the casualty unless he is in further danger. Movement following a spinal injury can be fatal, and individuals who have fallen might have spinal or internal injuries. Administer first aid using the first aid kit, if you know how. Only attempt more sophisticated forms of treatment (e.g. for broken bones) if you have been trained to do so - they are not normally life threatening.

Rapidly assess whether the casualty requires further medical attention. Depending on the urgency of the situation and the casualty's ability to be moved, you should decide which of the following evacuation options is best. Ideally, someone from the team should accompany the casualty.

1. Road transport:

By the nearest available vehicle, if the casualty can be moved and can wait up to two hours for medical treatment.

- Send a message or messenger by whatever means available to the nearest location where transport is available (project vehicle, taxi or other).
- The remainder of the team should then carry or escort the casualty to the location where they can link up with the transport.
- Using the Casualty Evacuation Message format below, telephone the project leaders, informing them of the situation and which hospital they will take the casualty to. If the team lacks a telephone, use the most effective communication method available.
- The project leaders will notify the hospital so they can make the necessary arrangements.

2. Helicopter

From any suitable landing site, if the casualty cannot be moved and/or requires the fastest possible means of evacuation.

- The project leaders will initiate the helicopter evacuation procedure and will notify the team of the evacuation arrangements.
- Move the casualty to the nearest site suitable for helicopter evacuation. A landing zone should be a clearing of at least 6 metres long by 4 metres wide.
- Using the Casualty Evacuation Message format below, telephone the project leaders, requesting medical evacuation. Note: if the team is not equipped with a telephone they should use the most effective communication method available.

At no time should you leave the injured person alone in the forest. Lighting a fire in a clearing will help keep them warm and reassured.

Casualty Evacuation Message

PLEASE use this format for your request for evacuation, it will ensure that all the necessary information is sent and received clearly.

CASUALTY EVACUATION MESSAGE

1. **LOCATION -** Current location of casualty - GPS reading or map co-ordinates (*note that the helicopter pilot may prefer latitude/ longitude to UTM grid reference* ***– which is it?***).
2. **TIME -** Of injury or illness being observed
3. **NUMBER OF CASUALTIES -** e.g. “one adult male”
4. **NATURE OF INJURIES OR SYMPTOMS -** e.g. "broken leg" or "severe fever and vomiting".
5. **TYPE OF EVACUATION REQUESTED -** e.g. helicopter or vehicle
6. **SUGGESTED EVACUATION POINT AND TIME OF ARRIVAL OF CASUALTY -** e.g. "current location at 13°55'38"N, 60°57'28"W" or "Vigie Airfield casualty will arrive at 4pm."
7. **ADDITIONAL INFORMATION -** Any extra information that you feel would facilitate the evacuation, but keep it brief.

This format is designed for use when requesting evacuation. If the team itself can make all the necessary evacuation arrangements, this format should still be used to inform the project leaders of the incident. Make clear if transport has been already been organised and inform them of where to meet the evacuation vehicle when it arrives.

Vehicles and driving

The leading cause of death among field expedition workers are driving accidents. St Lucia has a high average rate of road casualties (13.7 per 100,000 people)

Only staff that hold a driving licence or permit issued by the St Lucia police or the Ministry of Communications are permitted to drive. Drivers must be in possession of their driving licence and passport when driving. Local driving regulations must be adhered to, including the wearing of seat belts. St Lucia uses the UK Highway Code, with similar rules of the road and signs: a copy of the code is available in St Lucia. The speed limit on the highway is normally 40 mph (64 kph) and 20 mph (32 kph) in built up areas (including small villages), although many road users do not observe these limits.

Roads are very winding throughout most of St Lucia and often slippery when wet. The main highway is currently in fairly good condition, but new potholes are appearing all the time and drivers frequently swerve without warning to avoid them. Use the horn lightly to alert motorists if you intend to overtake them.

The most senior person in the vehicle is in command and is to ensure that it is driven safely and correctly at all times. Vehicles must not be loaded beyond the manufacturer's recommended level with people or stores. Sitting on the edge or sides of trucks, pick-ups etc. or on any other external part when a vehicle is in motion should be avoided. Drivers must not drink alcohol for at least ten hours before being on driving duty. The driver of a project vehicle is also responsible for keeping of the log book, which the Project Leader will provide.

It is also the driver's responsibility to check that the vehicle carries a basic tool kit, jack, and spare wheel. All vehicles should be checked daily for fuel, oil and water. Lights should also be checked. In case of a breakdown, be sure to have the telephone number of the car rental company. If a breakdown occurs during business hours, the company will send a mechanic to fix or exchange the car. If it is after business hours, leave the vehicle and report the breakdown first thing next morning.

Most hire cars are automatic, but private vehicles tend to be manual.

ACTIONS ON: VEHICLE ACCIDENTS

All accidents involving vehicles, however trivial, should be reported to the Project Leader and, in the case of rental vehicles, the car hire company. For Ministry of Agriculture insured vehicles (inc Durrell's Land Rover) *any* accident that will incur costs should be reported immediately to police and the Ministry of Agriculture)

In an accident involving injury or loss of life, the driver and passengers must report the accident to the police (dial 999) and summon an ambulance (911) without delay.

Do not move injured persons from the vehicle unless it is on fire or there is a risk of fire.

If damaged vehicles or debris are in the road, warn other traffic of the accident by placing signs or markers on the road. Try to find someone to help stop or direct traffic.

Minimise the risk of fire by switching off the ignition, disconnecting the battery, applying the handbrake and/or chocking the wheels.

River crossings

When crossing rivers, remember that still waters are often deep and have the softest substrate. If crossing large and/or fast flowing rivers, adequate safety ropes must be established before crossing. The person establishing the rope link must be the strongest swimmer and must carry a sharp knife in case of entanglement with the rope. Others should stand by to release the swimmer if necessary.

Travel by boat

All participants who travel by boat should be able to swim at least 500m in light clothing. A life jacket should be provided. If carrying a rucksack always slip one arm out of a strap when crossing water or boating.

The most senior person in the boat is in command, and is to ensure that it is manoeuvred safely and correctly at all times. Boats will not be loaded beyond a safe level with either personnel or stores. Petrol tanks are never to be refilled whilst an engine is running. Any petrol spillage must be immediately wiped up and spare fuel should be stored away from the engine or other working machinery. If a boat is powered, sufficient spare fuel and oil must be carried on board in order to reach the destination. Boats should not be used after dark. Outboard motors are only to be repaired by qualified mechanics, except in the event of a breakdown in a remote area where the passengers may need to effect the best repair possible.

The person responsible for a vessel is to ensure that the following are on board before a journey: tool kit and flares, basic first aid kit, pair of oars/paddles, bailer, anchor with chain and rope, charts of the area, navigational aids (e.g., compass) and lifejackets for everyone on board.

Seawater is highly corrosive. Engines, life jackets, and other essential parts should be washed in freshwater after use to prevent them failing in the future.

Venomous snakes

Snakes are not naturally aggressive, but may strike if they feel threatened. Take care even with supposedly dead specimens - people have received fatal reflex bites from dead and decapitated snakes. Snakes carry enough venom to bite more than once.

The best way to avoid a bite from a venomous snake is to stay away from it and not attempt to pick it up or kill it (many people get bitten while trying to kill snakes). The risk can also be greatly reduced with proper clothing: long trousers and leather boots will help protect against being bitten after treading on a snake. The project can also provide bite-proof gaiters or chaps. Watch out for snakes when brushing against vegetation, climbing trees, turning over logs and stones, collecting firewood, or examining holes and crevices. Pit vipers are most active at night, so it is important to be extra-vigilant and carry good torches when hiking at night.

It has been calculated that only 7% of St Lucia pit viper bites are fatal, and the death rate can be reduced to nearly 0% with use of antivenom. If a person is bitten and shows signs of envenomation, the hospital will therefore give them a course of antivenom (antivenin) injections. Antivenom treatment is most effective when given promptly after the bite, but can still work even several days later. Antivenom should be administered only by trained medical practitioners.

ACTIONS ON: SNAKEBITE

The person who is bitten

Move away from the snake. Make no attempt to catch or kill the snake.

Alert your colleagues immediately, but do not panic. Remember that snake bites are treatable, and that venomous snakes frequently inflict 'dry' bites with little or no venom is injected.

If your colleagues are out of sight, use your telephone or the international distress signal: SIX long blasts on the whistle every minute. It is best to sit still and let your colleagues come to your assistance.

The other team members

On hearing the distress signal, other survey participants should respond (THREE long blasts per minute) and decide the safest means of reaching the stricken individual.

Keep away from the snake. Make no attempt to catch or kill the snake unless that is the only way to avoid a second bite.

Gently wash the bitten area to remove any venom from the surface of the skin.

You must get the victim to hospital by the quickest route possible: you may use a project vehicle, ambulance (dial 911) or flag down a passing vehicle. Keep the patient as calm and still as possible, and prevent excited onlookers crowding around. Even if he/she feels able to walk, it is best to carry them on a makeshift stretcher or vehicle.

Watch the patient closely for any signs of cardiac (heart) or pulmonary (breathing) arrest, and be prepared to administer cardio-pulmonary resuscitation. If they vomit, lie the patient on one side so that fluid does not block breathing passages.

Allow the patient to drink plenty of water. You may provide Paracetamol (0.1-1.0g for an adult).

Do not give alcohol or aspirin. Do not apply a tourniquet. Do not attempt to cut, burn, apply ice, or suck the area around the bite wound (these methods promote infection and shock, and tourniquets can dangerously concentrate the venom's tissue-destroying enzymes, leading to the loss of the leg or arm).

If possible, notify the project leaders with an estimated time of arrival at hospital (indicate which hospital you will go to) and either you or the project leaders should warn the hospital to receive a snake bite patient.

Other dangerous animals

Scorpions, centipedes, hornets and rain spiders (tarantulas)

All of these have a painful, but generally not dangerous bite or sting. Shake out boots and clothing before putting on. Keep blankets, sleeping bags etc. wrapped up and pockets of rucksacks closed to avoid ingress of insects/animals. Kick or move dead wood, before picking it up and avoid sitting on rotten logs and in long grass. Bees and wasps are generally tolerant of people unless you get very close to or physically disrupt a nest.

Venomous fish and sea urchins

If swimming in areas with venomous fish (such as stone fish or scorpion fish) or sea urchins (in rocky areas), tread very carefully or wear sandshoes. The sting of these fish is immensely painful and the pain can best be relieved by immersion in very hot (but not scalding) water. Sea urchin spines are barbed and can become deeply and painfully imbedded for months. Try to remove the spine with tweezers from the first aid kit.

Jellyfish

Jellyfish sporadically appear in Caribbean waters. Stings from most species are painful, but calamine lotion, antihistamines and analgesics will help relieve the pain and swelling. Douse the affected area with vinegar to deactivate any unfired 'stingers'.

Sharks

Several species of large shark occur around St Lucia, but attacks on humans are virtually unknown. Do not approach sharks, however, and do not enter the water with an open (bleeding) wound. Under no account should fieldworkers attempt to fish using a spear gun – spear fishing is illegal and the bleeding fish may attract sharks.

Hazardous plants

Manchineel

The manchineel (*Hippomane mancinella*) is the most dangerous plant in St Lucia. The fruit of this tree, which look like little green apples, are highly poisonous (eating them can be fatal), while the sap is extremely caustic and, on contact with skin, can cause severe blisters. Contact with the eyes is said to be excruciating and can cause temporary blindness. Take extreme care when cutting through manchineel or, better still, go round it. Avoid touching or standing beneath manchineel during rain or while the leaves are still wet. If splashed with sap, rinse the afflicted area thoroughly (use clean freshwater by choice, but other fluids such as seawater, juice or even urine will do).

All fieldworkers should learn to recognise the manchineel tree in the field before starting work. The leaves are alternate, shiny, bright green and oval, 4-10cm long; they have unusually long yellow petioles and a pronounced drip tip. Manchineel is typically a seashore tree, attaining up to 15 metres in height, but can sometimes be found in dry rocky areas inshore.

Other dangerous plants

Cacti (e.g., prickly pear and the columnar cactus), cats claw, agave (century plant) and thorny acacia (cassie) are ubiquitous in dry forest areas, and gwi gwi palm and Lepini, all of which have spiny trunks (easy to grab without looking to balance yourself) are found in both dry and moist forests, so fieldworkers are strongly advised to wear tough field clothes with long sleeves and long trousers, and look before they grab at plants. Wounds should be kept clean, and embedded thorns extracted with tweezers.

Hurricanes and Tropical Storms

The difference between a tropical storm and a hurricane is speed: tropical storms have sustained wind speeds of 40-74mph, hurricanes in excess of 75mph. Hurricanes are further classified into five categories: Category Five hurricanes being the most dangerous, with sustained wind speeds of more than 125mph. One Category Five hurricane that struck the Lesser Antilles in October 1780 killed as many as 20,000 people. Both types of storm have winds revolving in a counter-clockwise direction and normally originate off the coast of Africa, striking the West Indies from the East. These storms are always given a name: the first storm of the year is given a name beginning with 'A', the second 'B' and so on through the alphabet. Their names are alternately male and female.

The hurricane season is May to November, with most activity in August and September. However, hurricanes and tropical storms can occur at almost any time of year. The latest hurricanes to affect St Lucia was Hurricane Allen (Category Four) on 4 August 1980, Hurricane Ivan in 2005 and Hurricane Dean (Category Two) on 17 August 2007. The island also experienced eight tropical storms during the same period.

Aside from the danger posed by high wind speeds, tropical storms and hurricanes are typically associated with a huge amount of rain, severe waves and a significant rise in sea level. Most structural damage and loss of life occur along the coasts.

The US weather authorities monitor all tropical storms and hurricanes as they cross the Atlantic (see www.nhc.noaa.gov) and warnings are usually issued to Caribbean islands several days in advance and relayed to the general public on local radio. The storms often build up rotational speed as they approach the shallower waters of the West Indies: thus a relatively mild tropical storm can suddenly develop into a hurricane just hours before striking land.

Hurricanes and tropical storms can last from six or more than forty-eight hours, so keep the radio on and be prepared for a long wait. If the hurricane makes a direct strike on St Lucia, you may experience up to two hours of blue skies and calm weather in the middle ('eye') of the storm, only to be swiftly followed by the most intense winds, lightening and rain.

Fieldworkers should also be aware that the power will be turned off as the storm approaches and, if the hurricane is severe, there may be severe and long-lasting damage to power lines, roads, vehicles, boats, water and other supplies throughout the country. Commercial planes are normally flown to safer countries and it may take several days before normal air services are resumed.

Fieldworkers are strongly advised to check local television, radio stations, and/or the internet every day for weather news, and to listen to the radio more frequently for updates if there is a storm on the way. A Hurricane or Tropical Storm Watch alert means that a hurricane or storm may threaten within 36 hours. A Hurricane or Tropical Storm Warning means that a hurricane or storm is expected within the next 24 hours and people should be finalising steps to secure the safety of themselves and their property. Fieldworkers should:

- Listen for latest bulletins from the national radio stations (St Lucia Radio 93.7-97.7 FM) or check out the government's meteorological website: http://www.slumet.gov.lc/ or http://stormcarib.com/ (for up to date NHC advisories at the bottom of the home page). Have a battery-powered transistor radio available because television and internet may be cut.
- Move away from low-lying areas and beaches.
- Not venture into the field or, if are already in the field, return to their house or a hurricane shelter
- Secure loose outdoor items around their accommodation, e.g., furniture, flower pots, litter.
- Fasten and secure windows and external doors, using wood boards.
- Store sufficient clean drinking water and food for at least three days. Ensure that the food does not need to be kept cold or cooked. If possible, bank enough water for washing and flushing the toilet.
- Get first aid kits, lanterns, candles, lighters and torches. Water supply, telephone land line and cellular networks, and electricity may be disrupted without warning. Make any important phone or internet communications prior to the storm.
- If you have a project vehicle, fill up the tank.
- Place important documents in a waterproof container
- Keep a list of important telephone numbers.

Refer to Annex B or the 'Blue Pages' in your telephone directory for more detailed advice.

ACTIONS ON: HURRICANES

If a Hurricane Warning is issued, all fieldwork should stop. The project leaders will consult with project staff on the best course of action. Overseas staff may choose to return home, but the airport will close when the storm approaches.

Official hurricane shelters are freely available in every district throughout St Lucia. If staying in a house or hotel, consult local residents for advice on protective measures, including boarding up windows and identifying the safest room to retreat to.

Open one of the windows or doors of your house on the side opposite to the one from which the wind is blowing. Close it when the wind direction changes and open another window or door on the opposite side to the wind direction. This is recommended as a means of balancing the pressure inside and outside the house to avoid damage to windows or the roof.

Do not leave your shelter during the 'eye' or until the storm has truly passed.

Listen to the radio for information on any damage. Do not go out unnecessarily even after the storm has passed, because the roads should be kept clear for emergency services and repairs.

General Health Care

Preventative care, symptoms and treatments

Eating and drinking

Clean eating and kitchen utensils and cooking pots after use. Avoid sharing eating utensils or personal water bottles, and keep water bottles and communal water containers scrupulously clean. Peel fruit and raw vegetables and/or wash them in clean water.

Replenish personal water bottles as soon as possible after depletion using clean freshwater. Drink enough to avoid dehydration and do not over consume alcohol. Visitors from temperate countries may find they will have to drink more water than they are used to, especially during the first few weeks while they acclimatise. If you do not drink enough water or if you push yourself too hard you will make yourself ill. As a rough guide to determining how much water you need, check the colour of your urine, but typically water consumption will be at least a few litres each day when working in the field.

First Aid and medical guidance

Each field team should have a first aid kit: see Annex A for suggested contents. Every group should carry a more substantial first aid kit, and be aware of how to use it. First aid kits must be inspected regularly and replenished when necessary. Individuals should be conversant with the basic principles of First Aid (e.g. recovery position, artificial resuscitation, bandaging, prevention of blood loss etc.).

Every person should learn their blood group and must note it on documents, in wallets etc. so that it can be quickly discovered in the event of an accident. Likewise, any allergies or dependencies on drugs.

Disposable gloves should be used when treating severe injuries, to prevent the transmission of AIDS, hepatitis B and other blood-borne diseases.

A normal body temperature is 37ºC (98.6ºF); more than 2ºC (4ºF) higher is a 'high' fever. A normal adult pulse rate is 60 to 100 beats per minute. As a general rule the pulse increases about 20 beats per minute for each 1ºC (2ºF) rise in fever. Respiration rate is also an indicator of illness: between 12 and 20 is normal for adults. People with a high fever or serious respiratory illness (like pneumonia) breathe more quickly than normal. More than 40 shallow breaths a minute usually signifies pneumonia.

Skin infections

It is very difficult to avoid minor cuts, burns, bites and scratches during field work. By themselves, these do not constitute a big problem, but can, if untreated, develop into a tropical ulcer. Ulcers occur when a small opening in the skin becomes infected by bacteria or fungus and becomes septic. Legs, especially shins, ankles and feet, and arms and hands, are particularly at risk. Ulcers can be large and heal very slowly under moist forest conditions.

Do not ignore a scratch, small burn or insect bite. Clean the wound with weak iodine solution applied with cotton wool or gauze swabs.

If a cut shows signs of infection, clean it again with iodine solution or, better still, 6% hydrogen peroxide to deodorise the wound, then apply small amounts of antibacterial cream. If the wound does not improve, you could try Canestan antifungal cream. Protect the wound with a clean dressing, ideally absorbent lint held in place with zinc oxide tape.

You should attend to the wound regularly by cleansing, disinfecting and changing the dressing. If the ulcer persists, seek medical advice. There are a number of expensive specialist wound management products for the treatment of stubborn ulcers.

Dressings

There is a wide variety of dressings for wound protection, each with its own special features and properties. In addition to the absorbent lint and zinc oxide tape recommended above, we advise you to obtain a variety of dressings.

Take a small supply of plasters for very minor uninfected wounds. A variety of retention bandages are also recommended: one open-woven bandage (1.5m x 5cm) for the protection and retention of absorbent dressings, and one cotton conforming bandage (3.5m x 7.5m) for the retention of dressings in awkward positions near joints. You should also have a support and compression crepe bandage (4.5m x 5cm) for light support for a sprain or strain injury. Retention bandages should be held in place using safety pins.

You should obtain 5cm x 5cm (small) and 10 x 10cm (large) low adherence dressings for exuding (oozing) wounds, bad ulcers and burns. Opsite waterproof dressing pieces are strongly recommended for working around water, in 10cm x 12cm pieces. These dressing pieces are sterile, extensible, waterproof and water vapour permeable. They can be applied directly to the wound and are useful where the wound requires protection from frequent exposure to water.

Pains

For headaches and other pains you should have a supply of over-the-counter painkillers. Paracetamol is less of an irritant to the stomach, reduces temperature and should be used if headache accompanies diarrhoea and vomiting. The anti-inflammatory properties of Aspirin and Ibuprofen make them useful for the treatment of pains resulting from sprains or pulled joints.

Diarrhoea, vomiting and constipation

Clean drinking water is essential for preventing stomach disorders. Questionable water (and this sometimes includes tap water) can be purified using iodine drops, Puritabs, or by boiling it for at least six minutes. High standards of camp cleanliness must be maintained, with appropriate storage of food and thorough attention must be given to personal hygiene. Wash your hands before handling food and after going to the toilet.

Such methods can combat infection, but many fieldworkers get stomach upsets at one time or another. You can resort to antimotility drugs, such as codeine phosphate tablets or Imodium, to control the discomfort and inconvenience in the short term, especially if you are on the move. These merely control the symptoms, however, and do not treat the cause. Do not use Imodium or other antimotility drugs if you have a high fever or are severely dehydrated.

You may also wish to obtain a supply of laxatives and indigestion tablets.

Diarrhoea, vomiting and fever can result in serious dehydration and subsequent loss of electrolytes. Fluid replacement is essential. Weak black tea with a little sugar, soda water, or soft drinks allowed to go flat and diluted with water are all good. In the case of severe diarrhoea, a rehydrating solution is invaluable for replacing lost minerals and salts. Commercially available oral rehydration salts (ORS), such as Dioralyte and Rehydrat, are easy to use: add the contents of one sachet to a litre of boiled or bottled water. In an emergency you can make up a solution of eight level teaspoons of sugar or honey and two teaspoons of salt to a litre of boiled water. At the same time avoid dairy products, greasy or spicy foods, coffee and most fruit, in favour of blander foodstuffs such as eggs, bread, rice, noodles, banana, papaya and soup.

Consult a doctor if the problem persists: he or she may prescribe Metronidazole (which produces severe nausea if consumed with alcohol), an antimicrobial drug effective against anaerobic bacteria and protozoa. In certain situations, a need for more powerful antibiotics may be indicated:

- Diarrhoea with blood and mucous (gut-paralysing drugs should be avoided in this situation),
- Watery diarrhoea with fever and lethargy,
- Persistent diarrhoea for more than five days,
- Severe diarrhoea (use antibiotics if it is logistically difficult to stay in one place).

For more severe cases, the doctor may prescribe Norfloxacin (400mg twice daily for three days) or Ciprofloxacin (500mg twice daily for three days).

Personal hygiene

Keep yourself, your clothes, sleeping bag and all other equipment (especially boots) clean. Inspect yourself daily for insect bites and scratches and treat as necessary. Clean, dry and powder feet and skin folds daily if necessary. Prevent ear infections from swimming by drying ears well. Wear adequate clothing to avoid sunburn or sunstroke. If using underwear, ensure it is cotton – in hot, humid climates damp underclothes can cause rashes. Never walk barefoot and use adequate footwear (not flip-flops).

Fungal infections

Hot weather fungal infections are most likely to occur on the scalp, between the toes and fingers (athlete's foot), in the groin (jock itch or crotch rot) and on the body (ringworm). Ringworm - which is a fungal infection, not a worm – can be contracted from infected animals or by walking on damp areas, including shower floors.

To prevent fungal infections, wear loose, comfortable clothes, avoid artificial fibres, wash frequently and dry carefully. If you do get an infection, wash the infected area daily with a disinfectant or medicated soap and water, and rinse and dry well. Apply an antifungal powder such as the widely available Tinaderm. Try to expose the infected area to air or sunlight as much as possible and wash all towels and underwear in hot water as well as changing them often.

Rashes and bites

Another cause of wound infection and ulcers is the scratched mosquito bite or rash. Rashes can result from abrasion - for which you may use zinc and castor oil ointment – or from allergies, including prickly heat, or insect bites - for which we recommend antihistamine cream. Creams containing steroids or antibiotics are most effective. Oral antihistamine tablets will relieve hay-fever type allergic reaction, stubborn allergy rashes and the symptoms of insect bites, but remember these tablets react with alcohol, so reduce your intact or abstain. Ask the pharmacist for advice on antihistamine tablets that do not cause drowsiness.

If you are prone to collapse or anaphylactic shock when bitten or stung by insects, wear a Medi-alert bracelet all the time and ensure that other members of your party are aware of your condition. You may consider carrying an epi-pen: this contains a single dose of adrenaline for instances of anaphylactic shock. If you require an epi-pen you will need to source it from your doctor.

Try and avoid scratching rashes and bites, because this is how they become infected (see above). Instead, try rubbing gently, or have a lukewarm bath or shower. If irritation is severe, try using sleeping tablets at night.

Protection from insect bites

Wear long sleeves to cover your arms and long trousers. Avoid dark coloured clothing (this is debatable). Ensure tent flaps and mosquito nets are securely fastened, and kept closed whenever possible. Avoid using perfumes and aftershave.

Repellents with between 30 to 50% DEET (diethyltolumide) are the most effective. Higher dosages are also available to treat clothing. This chemical is toxic: keep it away from eyes and open wounds. It also dissolves plastics, such as wristwatch straps, sunglasses, tents and GPSs. DEET sometimes causes bad dreams, nausea and dizziness, in which case try a less toxic alternative. Use these sprays at dawn and dusk, and also during the day in dengue risk areas. Wash the excess off your skin before going to bed.

When sleeping in the forest or other mosquito-prone areas, use a mosquito net and ensure it is correctly fitted. Nets can be soaked with permethrin to discourage insects from landing and biting you through the net. Mosquito coils and plug-in repellents are very effective indoors, but not in the field.

Heat exhaustion

Dehydration or salt deficiency can cause heat exhaustion. Take time to acclimatise to high temperatures and make sure you drink sufficient liquid. Salt deficiency is characterised by fatigue, lethargy, headaches, giddiness and muscle cramps: in this case salt tablets may help. Vomiting or diarrhoea will deplete your liquid and salt levels.

Heat stroke

This serious, sometimes fatal condition can occur if the body’s heat-regulating mechanism breaks down and the body temperature rises to dangerous levels. Long, continuous periods of exposure to heat can leave you vulnerable to heat stroke. The symptoms are feeling unwell, not sweating very much or at all and a high body temperature (39ºC to 41ºC, or 102 to 106ºF). Nausea is common too. Where sweating has ceased the skin becomes flushed and red. Severe, throbbing headaches and lack of coordination will also occur, and the sufferer may be confused or aggressive. Eventually the victim will become delirious or convulse. Hospitalisation is essential, but meanwhile get victims out of the sun, remove their clothing, cover them with a wet sheet or towel and then fan continuously.

Sunburn

As in most tropical countries, it is easy to burn in the sun. Sun-block of varying strengths is available in pharmacies. Wearing a hat and long sleeves/pants may also be advisable.

Miscellaneous

If you suffer from cystitis or other urino-genital disorders you should ensure that you have a supply of bicarbonate of soda (for cystitis) and some Nystan or other pessaries for fungal infection.

If you are prone to eye infections or mouth ulcers ensure that you obtain appropriate medication to cope with these conditions. Multivitamin pills can help increase your resistance to infection.

Note that St Lucia has excellent pharmacies where such remedies can be purchased.

Note on clothing: Waterproofs are useful for frequent showers, and waterproof gaiters may confer some of the advantages of both hiking boots and Wellington boots, though the latter are preferred by many St Lucians in forest environments. Thick hiking socks typically make the use of boots a more comfortable experience. A hat or scarf, and sunglasses, are useful in the sun.

External Parasites

Jiggers/ chiggers

Female fleas lay eggs under the skin, usually in feet and lower legs. The eggs, or jiggers, hatch into small worms. These can be awkward to extract and have to be removed using a needle or a small scalpel blade (stitch cutter). Jiggers can be best avoided by always wearing shoes around camp and using insect repellent.

In St Lucia, chiggers refer to almost microscopic red mites that burrow under the skin. They typically infest areas where clothes end or begin: wrists, necklines and particularly ankles and waists. They itch and, unlike mosquito bites, do not stop itching until removed. DEET on clothes in these body areas seems to be the best preventative. The best treatment is said to be coating the infected area with baby oil (mineral oil) to suffocate the mites. They seem to be associated mainly with long grassy vegetation, but they occur in forest too; so avoid sitting down in these areas.

Ticks

Ticks can be removed using fine-pointed tweezers: grasp the tick's head as close to the skin as possible. Use a slight to-and-fro action to lever, rather than pull, the head out. The mouthparts will be very firmly embedded in the skin; try to avoid breaking the tick and leaving the buried head behind. Alternatively, remove ticks with alcohol or oil.

Conclusion

Though you may be able to deal with the above problems yourself, you must also keep your colleagues aware of your symptoms, especially headaches and stomach pains, because they may signify something more serious. Remember that the state of your health affects the entire camp. Be responsible for your health and keep an eye on the condition of others – certain illnesses are more obvious to other field-workers than to the individual afflicted.

Infectious Diseases

Infectious diseases are rare on St Lucia, but fieldworkers should be aware of the following:-

Dengue Fever

Dengue fever is a viral condition transmitted by mosquitoes to humans. The disease is widespread in the tropics and subtropics and occurs commonly in Asia, coastal tropical Africa and Latin America (including the West Indies) between 30º North and 40º South.

The disease is transmitted to humans through mosquito bites. Most mosquitoes that transmit dengue (the black-and-white striped ones) feed during the daytime. No vaccine is available against Dengue fever and so the main form of defence is protection against mosquito bites. The treatment for simple dengue is painkillers and rest for about two weeks, if not longer. Field workers from overseas may be best advised to return home.

There may be no symptoms for between two and seven days following the bite. During this incubation period, the virus multiplies in the nearest lymph glands before invading into the deeper organs. The disease usually then presents with an abrupt onset of high fever (40ºC) and the patient typically develops severe muscle pains and other significant 'flu-like symptoms. Joints are usually very painful to move and this gives rise to the other name for Dengue: 'Break Bone Fever'. An early skin rash may be seen and the patient typically will have a splitting headache and need to lie down in a darkened room. (Note that meningitis may be considered as a possible diagnosis under these circumstances).

Four different types of the Dengue virus are recognised: serotypes 1, 2, 3 and 4. The various serotypes are found in different regions of the world and, following infection with one serotype, the individual will maintain a long-standing immunity against that particular strain of the disease but not the others.

After a few days the patient may appear to recover, but then become ill again with the second phase of the illness. (This biphasic pattern helps in diagnosing this disease). A more significant skin rash occurs and the patient's joints may become somewhat swollen. Headache and prostration are also common. In most cases, the severe stages of the disease last for about two weeks but most of those infected will recover fully. This recovery stage can last for months, however, and some patients will experience significant debility. Mental depression is common.

Dengue is mainly diagnosed from the clinical signs (headache, fever, joint pains and skin rash), but confirmation requires a blood test to show the presence of antibodies in the patient's blood. However, this test may not show a positive result for several weeks after symptoms begin.

If you believe you have been exposed to the disease, you should obtain medical advice urgently and may require admission to hospital. Fluid balance must be maintained and your temperature may need to be controlled. In some regions it may be difficult to differentiate the disease from Typhus and so the doctors may consider using Tetracycline antibiotics until the blood results are through. Most people recover completely after a week or two of rest, Paracetamol and plenty of fluids. Aspirin should be avoided because it provokes internal bleeding.

Patients who have been correctly diagnosed with Dengue Fever should be aware that a second exposure within six months may lead to the more severe, sometimes fatal, form of the disease: Dengue Hemorrhagic Fever (below). It is advisable to avoid being bitten by dengue mosquitoes during this critical six month period.

Dengue Hemorrhagic Fever (DHF)

This is the extremely severe form of the disease, causing at least 45,000 deaths each year throughout the world. Although most common in Southeast Asia, it has more recently been confirmed in the Pacific and Caribbean islands. The actual cause of this disease is still not fully understood, but it has been suggested that it may result from infection with different forms of dengue within a six month period. The individual's blood vessels lose their integrity and allow body fluids to ooze out into the surrounding tissues. This rapidly leads to profound shock, high temperature, a severe skin rash, and, in many cases, death.

Intestinal Worms

These are not uncommon, but are rarely serious. Hookworm can be contracted from walking barefoot on infested earth or beaches.

Typhoid

Typhoid fever is another gut infection that travels the faecal-oral route, i.e., from contaminated water and food. Vaccinations against typhoid are not entirely effective. Because typhoid is potentially lethal, medical help must be sought.

In its early stages, typhoid resembles many other illnesses. Sufferers may feel like they have a bad cold or 'flu on the way, with a headache, sore throat, and a fever which rises a little each day until it reaches around 40ºC (104ºF) or more. Their pulse often gets slower as the fever rises (unlike a normal fever where the pulse increases). There may also be vomiting, diarrhoea or constipation.

In the second week, the high fever and slow pulse continue and a few pink spots may appear on the body. Trembling, delirium, weakness, weight loss and dehydration are also common symptoms. If there are no further complications, the fever and other symptoms will slowly go during the third week. You must get medical help before this stage, however, because of the risk of pneumonia (acute infection of the lungs) or peritonitis (perforated bowel).

The fever should be treated by keeping the patient cool and hydrated. The usual drug of choice is Ciprofloxacin at a dose of 1g daily for 14 days. A cheaper alternative, Chloramphenicol, has been the mainstay of treatment for many years (the adult dosage is two 250mg capsules four times a day).

Hepatitis (Jaundice)

Hepatitis A is common in areas with poor sanitation, being spread by contaminated food or water, The symptoms are fever, chills, headache, fatigue, feelings of weakness and aches and pains, followed by loss of appetite, nausea, vomiting, abdominal pain, dark urine, light-coloured faeces and jaundiced skin. The whites of the eyes may also turn yellow. You should seek medical advice, but there is not much you can do apart from rest, drink lots of fluids, eat lightly and avoid fatty foods. People who have had hepatitis should forego alcohol for six months after the illness because hepatitis attacks the liver, which takes time to recover.

The more serious Hepatitis B is spread through contact with infected blood, blood products or bodily fluids (for example, through sexual contact, non-sterile needles and blood transfusions, or via small breaks in the skin). Other risky situations include having a shave or tattoo in a local shop, or having your body pierced. The symptoms of type B are much the same as type A, but more severe and may lead to irreparable liver damage or liver cancer.

Vaccines are available against both hepatitis A and hepatitis B.

Schistosomiasis (Bilharzia)

This disease is carried in water by minute worms, which infect certain fresh water snails in rivers, streams, lakes and, especially, behind dams. The worms multiply and are eventually discharged into the water surrounding the snails. They attach themselves to your intestines or bladder, where they produce large numbers of eggs. The worm enters through the skin, and the first symptom may be a tingling sensation and sometimes a light rash around the entry site. Weeks later, when the worm is busy producing eggs, a high fever may develop. A general feeling of being unwell may be the first symptom, but once the disease is established, abdominal pain and blood in the urine are other signs. The infection often causes no symptoms until the disease is well established (several months to years after exposure) and damage to internal organs irreversible.

The disease is endemic in St Lucia, Guadaloupe and Martinique, but may be declining due to improved sanitation. Avoid swimming or bathing in fresh water ponds or rivers. If you do get wet in bodies of freshwater, dry off quickly and change into dry clothes.

Seek medical attention if you have been exposed to the disease. Beware that bilharzia in the early stages can be confused with malaria or typhoid. Doctors are likely to prescribe Praziquantel (Biltricide): the normal dosage is 40mg/kg in divided doses over one day. Niridazole can be used as an alternative.

Leptospirosis

Various forms of leptospirosis occur in most of the Caribbean islands transmitted by a bacterium that is excreted in the urine of mammals such as rats and mongooses. Fresh water and moist soil can harbour this bacterium, which enters the body through cuts and scratches. Symptoms resemble flu and can include fever, chills, headaches, muscle pain, vomiting and diarrhoea. More severe symptoms include jaundice and blood in the urine. Leptospirosis can be fatal, so consult a doctor if you suffer any form of prolonged fever.

Tetanus

This is caused by infection of wounds with a faecal bacterium. Symptoms include difficulty in swallowing or stiffening of jaw or neck, leading to convulsions. Tetanus is difficult to treat, and team members should arrange their own vaccinations. The probability of infection is increased by failure to wash and cover wounds (even pinpricks and abrasions) or be vaccinated.

Rabies

Workers with mammals, especially bats, are at increased risk of contracting rabies, and are strongly advised to get vaccinated in advance. Other animals (non-mammals) do not carry this disease. Once symptoms appear - which can take anything from a few days to several months after exposure - rabies is untreatable and almost invariably fatal in humans. All fieldworkers should avoid unnecessary contact with mammals, especially strays, and handle wild mammals with extreme caution. Any bite, lick or scratch should be washed immediately using soap, running water and alcohol. Rabies has not been recorded from St Lucia, but is on nearby Grenada and Puerto Rico where mongooses are one vector.

Human diploid vaccine can be sourced from Trinidad and administered (pre- or post-exposure) by the St Lucia health authorities. It is recommended that workers who have already had pre-exposure vaccination (or post-exposure treatment) should have their rabies antibodies titred before receiving further booster doses, but this service might not be available in St Lucia.

AIDS/ HIV

AIDS is common in the Caribbean, especially Haiti, Dominican Republic, Trinidad and the Bahamas. The AIDS virus (HIV) can be passed via non-sterile needles and especially through unprotected sex.

ANNEX A: FIELD FIRST AID KITS

This kit is for emergency use in the field. You are strongly advised to consult a doctor as soon as you reach a town or city.

Water purification tablets (one of these)

- 'Puritabs': Use 1 tablet per litre of water. Wait 10 minutes before drinking.
- 'Micropur': Use 1 tablet per litre of water. Wait 2 hours before drinking.
- 'Iodine': 5 drops per litre. Wait 30 minutes.

Disinfectant

- 'Betadine' Iodine solution to clean cuts and wounds. Apply at least twice a day.

Dressings/ Bandages for wounds

- Sterilized compress dressings for large wounds. Hold this in place with bandage and adhesive tape.
- Adhesive cloth tape. To hold dressings in place.
- Crepe bandage to support sprains or weak joints.
- Elastic bandage for general dressings.
- Absorbent lint or cotton wool ('Hydrophile Gazebinde', 'Bande Individuel') for cleaning and dressing large wounds.
- Plasters (Urgo) for minor cuts and grazes.
- Triangular bandage (not essential but can be very useful)

De-hydration control

- Oral Rehydration Salts (O.R.S.). If you feel weak from lack of water. Dissolve 1 packet in 1 litre of water, and drink.
- Anti-emetic ('Motilium', 'Primperan') to stop vomiting. 1 tablet 3 times a day
- Imodium to stop diarrhoea. Take no more than 4 capsules total in 24 hours. Try not to take this as it can prolong illness through suppression of the body's natural immune response.

Pain killers

- Paracetamol ('Paralgin') for general pain, headaches and fever. 2 tablets 3-4 times a day. No more than 8 tablets total in 24 hours.

- Ibuprofen (‘Advil 200mg’, ‘Antarene 400mg’, ‘Buprol 400mg’) to stop inflammation pain and sprains. Not more than 1200mg (three Antarene tablets or six Advil tablets in 24 hours).

Antihistamines, Antifungals, Antibiotics

- Antihistamine cream (‘Phenergon’) for relief from itching skin. Spread cream over the itchy area.
- Antihistamine tablets (‘Hismanal’, ’Cetizine’) for severe allergic reactions: sneezing; runny nose; itchy, watery eyes; itchy throat; severe itchy skin. 1 tablet a day.
- Anti-fungal cream (‘Mycoril Cream’) for athlete’s foot and other fungal infections of the skin. Spread cream over the area.
- Antibiotic cream (‘Flamazine’). Put this cream on ulcers and infected wounds.

Burns

Cold water should be poured over burn site for 10min or more till heat is dispelled, no cream oil, or lotion should be applied until after cooling as this will lock in heat and worsen the injury.

Burn shield should be applied to sever burns

Your kit may also contain:

- Sterile surgical blade to make cuts/ incisions
- Sterile surgical sutures to sew up very bad wounds
- Eye drops for itchy or damaged eyes
- Ear drops for ear-ache.
- Sterile needles (for removing parasites).
- Safety pins.
- Insect repellent.
- Surgical scissors.
- Tweezers.
- Thermometer.
- Gloves (sterile).
- Gaffer tape

When these items are used, they should be replaced promptly. Ask at the project office or purchase replacement items from a good pharmacy.

Note that Snake Venom Kits (including suction devices) are ineffective and not recommended.

ANNEX B: HOSPITALS

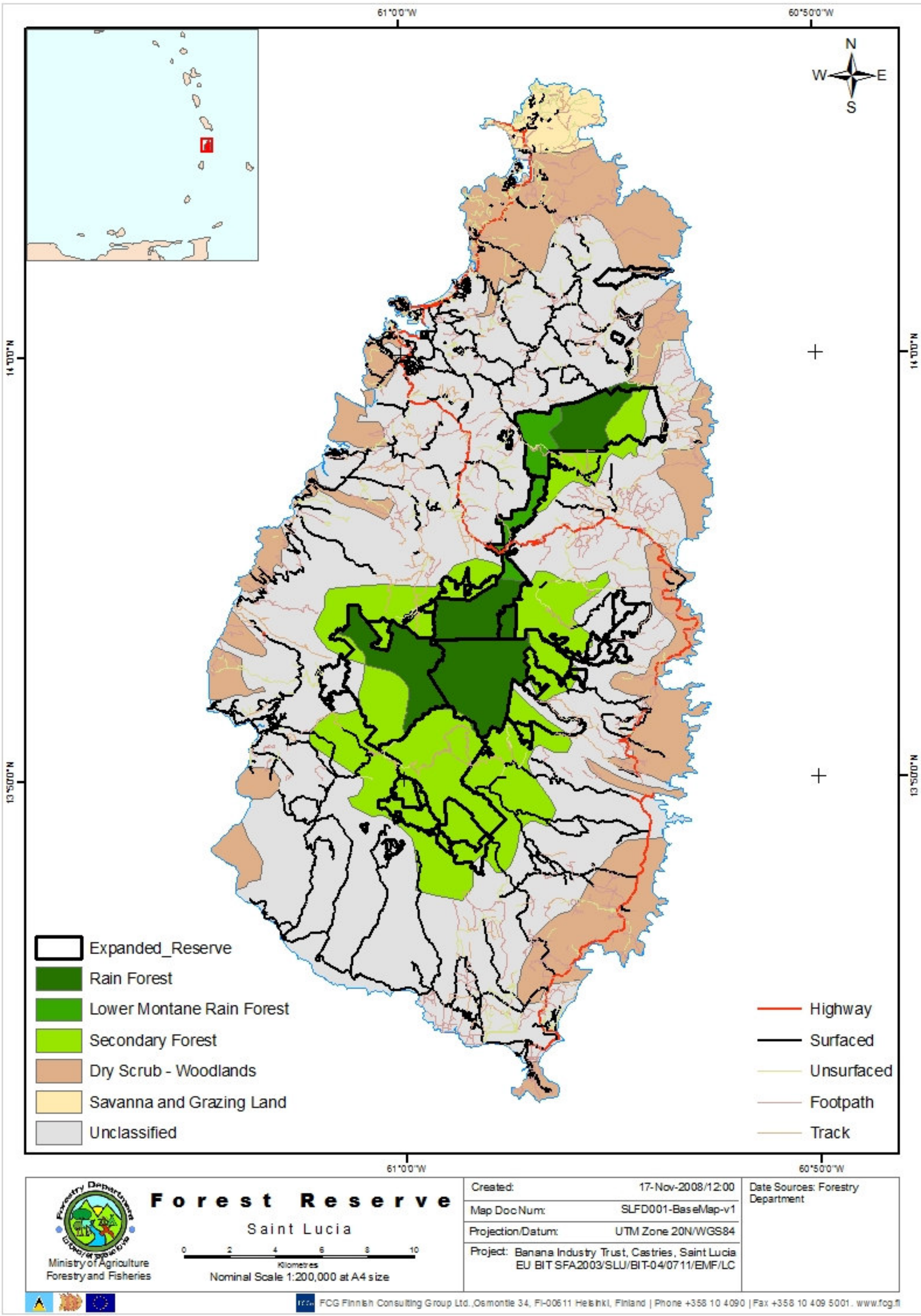
(maps removed to reduce size)

ANNEX C: HURRICANE AND STORM ADVICE

The following advice has been taken from the St Lucia Government Blue Pages.

(material from Blue pages removed)

Annex 7 Example of map produced by project GIS system



Annex 8 Curriculum Vitae - Roger Graveson

Personal information	
First name(s) / Surname(s)	**Roger Stephen Graveson**
Address(es)	Box 2074, Gros Islet, St. Lucia.
Telephone(s)	1 758 4500765
E-mail	augustinh@candw.lc
Nationality	Saint Lucia
Nationality	United Kingdom
Date of birth	06/03/1950
Gender	Male
Desired employment / Occupational field	National Forest Demarcation and Bio-Physical Resource Inventory Project in St. Lucia. Botanical expertise.
Work experience	
Dates	01/01/1995 - 01/01/2008
Occupation or position held	Field Botanist (volunteer, occasional paid consultancy) in St. Lucia.
Main activities and responsibilities	Collection, identification and preparation of herbarium specimens. 2000 specimens (approximately) lodged at University of Rio Pedras, Puerto Rico to validate my research, plus 2,500 locally. Compilation of flora check list, including 250 approx. vouchered new records. Full vouchered floral check list of Saint Lucia – to be published. Library of 11,000 labelled images. Consultant botanist to Department of Forestry, National Trust, CEHI and consultant on six IEA's in St. Lucia and Grenada.
Type of business or sector	Botanical research.
Work experience	
Dates	01/09/1975 - 30/06/1989
Occupation or position held	High School Biology Teacher
Name and address of employer	Service College, Benfleet, Essex Port Moresby High School, Papua New Guinea. Henry Compton School, Fulham, London. Bermuda High School, Bermuda. Colegio Internacional de Carabob0, Valencia, Venezuela.

Type of business or sector	Education.

Education and training

Dates	1/10/1973-30/06/1974
Title of qualification awarded	Postgraduate Certificate of Education.
Principal subjects/occupational skills covered	Education.
Name and type of organisation providing education and training	Institute of Education, London University.

Education and training

Dates	1/10/1968-30/06/1971
Title of qualification awarded	BA Cantab., upper Second Class Hons.
Principal subjects/occupational skills covered	Natural Sciences trips.
Name and type of organisation providing education and training	Cambridge University.

Annex 9 Curriculum Vitae - Matthew Morton

Matthew Nicholas Morton

Personal

Address: c/o-	Forestry Department	Telephone:	(+758) 719 8966 (m)
	Ministry of Agriculture		(+758) 453 4866 (h)
	Castries		
	St Lucia	Date of Birth:	24/12/63
W. I.		Nationality:	British

Profile

Since 2001, I have been based in St Lucia, working closely throughout with Durrell's in-country partners the St Lucia Forestry Department (Ministry of Agriculture) on a number of species conservation projects. In 2006 I was given a Ministry of Agriculture award for Durrell's "outstanding contribution and support" to conservation efforts in St Lucia. Prior to my current position, I worked on a number of overseas conservation contracts on various islands in the Eastern Caribbean, as well as in West Africa, with a focus on bats and reptiles. I am a member of IUCN's Iguana Specialist Group.

Education

BSc (Hons) Zoology, Upper II (University of Bristol, U.K.)
A Levels: Biology (A); Chemistry (B); Mathematics (E)

Employment

2002-present	Eastern Caribbean Manager, Durrell Wildlife Conservation Trust (Durrell) Projects in St Lucia, Antigua & Barbuda, Montserrat
2001-02	St Lucian Iguana Project, Principal Investigator (Durrell Wildlife).
2001	Invasive Species Control fieldworker, Antigua (Fauna & Flora International).
2000	AutoCAD technician, Clarkebond Civil Engineering.
1999	St. Kitts & Nevis Biodiversity Project (UNDP/FCO); bat biodiversity surveyor. Researcher (temp) BBC Natural History Unit.
1998	Training Officer (I.T.), MARI Group Ltd delivering OCR CLAIT and IBT2 and City & Guilds 4351 AutoCAD (level 1).
1994-7	Consultancies and field surveys (primarily bat surveys, UK, E. Caribbean, W. Africa)
1993	*Iguana delicatissima* Radio tracking Project, Dominica (Durrell, San Diego Zoo)
1992-87	Consultancies and field surveys (herptile, bat, woodland surveys, UK, W. Africa)

Referees

Dr J. E. Fa	Dr. Jenny Daltry
Durrell Wildlife Conservation Trust	Fauna & Flora International
Les Augrès Manor	Great Eastern House
Trinity	Tenison Road
Jersey JE3 5BP	Cambridge CB1 2TT
United Kingdom	United Kingdom
Tel: +44 (0)1534 860 000	

Annex 10 Curriculum Vitae - Frank Clarke

Date	Award	Awarding body
1999	Thomas Henry Huxley Medal	Awarded by the Zoological Society of London for the best "original work submitted as a doctoral thesis".
1999	PhD	University College (UCL), University of London, UK.
1994	BSc. Honours Zoology	University of Glasgow, UK.

Posts Held

Date	Organisation(s)	Post
present	Zoological Society of London, Fauna & Flora international	**Consultant** on project "Addressing a threat to Caribbean Amphibians**"**
2006-07	Wildlife Conservation Society-Papua New Guinea.	**Conservation Biologist**. Lecturer and field instructor to BSc. Conservation Biology students: WCS-PNG scientific capacity building program 2006/07.
2004-06	Zoological Society of London Fauna & Flora International Environmental Management Consultants (EMC) Iwokrama International Centre for Rain Forest Conservation	**Biodiversity specialist**. Responsible for biological inputs to activities of Fauna & Flora International and Zoological Society London in West Indies, Guyana and Belize e.g. Conserving the National Flower of Dominica; Amphibian Monitoring and Chytridiomycosis Surveillance in Dominica; Biodiversity Assessments of Halcrow and Guysuco Conservancies; development of Forest Impact Monitoring system to examine impact of logging on the vertebrate fauna of Guyana's Iwokrama Forest.
2000-03	University of Aberdeen, UK.	**Post-Doctoral Research Fellow.** Effect of different logging systems and plantation forestry on the species diversity of Trinidad's mammal communities: evaluating 'ecological sustainable logging'.
1999-00	University of Pretoria, RSA.	**Post-Doctoral Research Fellow.** Ecology and behaviour of Bathyergid rodents in Namibia and South Africa.

Research Interests

Wildlife Ecology and Conservation. Understanding the factors shaping patterns of vertebrate diversity in the tropics and the impact of natural (e.g. hurricanes) and anthropogenic forest disturbance (e.g. logging systems, forest fragmentation) on vertebrate communities. Sustainable management of tropical forests, biological considerations for protected area management, and ecological monitoring.

Teaching Experience

- Lecturer and field instructor to BSc Conservation Biology students in Papua New Guinea.

- Lecturer on the University of Aberdeen courses: Forest and Savanna Ecology, Biological Conservation in the Tropics, and International Perspectives in Conservation Biology.
- Scientific capacity building in Dominica, Belize, Trinidad & Tobago and Guyana: training Forestry and Wildlife Officers, NGOs, 'grassroots' conservation groups (indigenous peoples) in biodiversity assessments and monitoring, biological considerations for protected areas, research and analytical skills, report and grant writing.
- Supervisor of a PhD student investigating the factors shaping patterns of mammal diversity in the Yucatan, Mexico.
- Graduate and undergraduate students trained in ecological methods, supervision of research projects in the West Indies, Southern Africa and Papua New Guinea.

Other Skills

- Extensive experience developing and implementing methods for biodiversity assessments and biodiversity-monitoring. Techniques include radio-telemetry, camera photo trapping, linear-transects for large mammals, small mammal trapping, amphibian and reptile survey methods, mist netting and canopy netting (bats & birds), tree-climbing, acoustical monitoring of animal calls and computer analysis of sound.
- Strong computing and statistical skills. Administrative experience includes one year employment as an office administrator with Smyth International Advertising.

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1. **Clarke, F.M.** and Racey, P.A. (in prep.). Chiroptera as indicator species: a review. *Biological Conservation*.
2. **Clarke, F.M.**, Boodram, D., and Racey, P.A. (in prep.). Natural forest management in Trinidad, West Indies: implications for mammal conservation. *Biodiversity and Conservation*.
3. MacSwiney, M.C., Cimé, B.B., **Clarke, F.M.** and Racey, P.A. (submitted). Insectivorous bat activity at cenotes (water-filled sink-holes) in the Yucatan Peninsula, Mexico. *Acta Chiropterologica.*
4. **Clarke, F.M**. and A. James (in prep.) Conserving Dominica's national flower *(Sabinea carinalis)* and dry scrub forest*. ORYX.*
5. MacSwiney, M.C., **Clarke, F.M.** & Racey, P.A. (In Press). Methods at maximising inventory completeness in neotropical bat assemblage studies. *Journal of Applied Ecology.*
6. Pio, D.V., **Clarke, F.M.,** Mackie, I., & Racey, P.A. (In Press). Echolocation calls of the bats of Trinidad, West Indies: is guild membership reflected in echolocation signal design? *Acta Chiropterologica.*

Referees

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Professor Paul Racey (Regius Professor of Natural History). School of Biological Sciences, University of Aberdeen, Aberdeen AB24 2TZ, Scotland, UK. Tel. +44 (0)1224 272 858. Fax. +44 (0)1224 272 396. Email: p.racey@abdn.ac.uk

Dr. Christopher Faulkes (Senior Lecturer), Biological Sciences, Queen Mary (University of London), London E1 4NS, UK. Tel. +44 (0)20 7882 3018. Fax. +44 (0)20 8983 0973. Email: c.g.faulkes@qmul.ac.uk

Annex 11 Curriculum Vitae - Michael Ivie

Michael A. Ivie
Montana Entomological Collection
Department of Plant Sciences and Plant Pathology
Marsh Laboratory, Room 5
Montana State University
Bozeman, Montana 59717-7030
Phone: (406) 994-4610
mivie@montana.edu

Personal.

Nativity: 16 August 1954, Modesto, California, USA.

Married, two adult sons.

Tertiary Education.

Ph.D. 1985. Entomology (Systematics). The Ohio State University, Columbus, Ohio. Title of dissertation: Phylogenetic Studies in the Bostrichiformia (Coleoptera).

M.S. 1981. Entomology. The Ohio State University, Columbus, Ohio. Title of thesis: The Coleoptera of the Virgin Islands - Bostrichidae.

B.S. 1977. Entomology. University of California, Davis, California.

1972 - 1974. Modesto Junior College, Modesto, California.

Honors.

Fellow, Royal Entomological Sociey, London.

Professional Employment.

2005-current Associate Professor and Curator, Department of Plant Sciences and Plant Pathology, Montana State University, Bozeman. (80% research, 20% teaching).

1992-2005. Associate Professor and Curator, Department of Entomology, Montana State University, Bozeman. (80% research, 20% teaching).

1998-1999. Interim Director, Mountain Research Center, Montana State University, Bozeman.

1985-1992. Assistant Professor and Curator, Department of Entomology, Montana State University, Bozeman.

1990-1991. Associate Program Director, Systematic Biology Program, National Science Foundation Washington, DC.

1985. Program Assistant, Integrated Pest Management Program, Ohio Cooperative Extension Service, The Ohio State University, Columbus.

1980-1985. Graduate Teaching/Research Associate, Departments of Entomology and Zoology, The Ohio State University, Columbus, Ohio.

1978-1980. Extension Agent-in-Charge, St. Thomas - St. John District, College of the Virgin Islands Cooperative Extension Service, and Adjunct Professor of

Agriculture, Division of Science and Mathematics, College of the Virgin Is., St. Thomas.

1976-1978. Extension Assistant, University of California Cooperative Extension, Sonoma and Stanislaus Counties.

1977. Agricultural Aide and Agricultural Inspector seasonal) in Biological Control and Cling Peach Inspection programs respectively, California Department of Food and Agriculture, Sacramento and Modesto, California.

1974-1976. Research Assistant, Department of Entomology, University of California, Davis, California.