USAID | LIBERIA
FROM THE AMERICAN PEOPLE

PEOPLE, RULES AND ORGANIZATIONS SUPPORTING THE PROTECTION OF ECOSYSTEM RESOURCES (PROSPER) PROGRAM

BIOMONITORING HANDBOOK FOR COMMUNITY FORESTRY IN LIBERIA

APRIL 2013

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech.

This document was prepared for the United States Agency for International Development, Contract No. AID-669-C-12-00004 People, Rules and Organizations Supporting the Protection of Ecosystem Resources (PROSPER) Program.

Principal contacts:

Steve Reid, Chief of Party, Tetra Tech, Monrovia, Liberia, steve.reid@tetratech.com
Dimitri Obolensky, Project Manager, Tetra Tech, Burlington, Vermont, dimitri.obolensky@tetratech.com

Prepared by:
Fauna and Flora International, April 2013

Implemented by:

Tetra Tech
P.O. Box 1397
Burlington, VT 05402
Tel: 802-658-3890

Tetra Tech PROSPER Program
19th Street & Payne Avenue
Sinkor
Monrovia, Liberia

PEOPLE, RULES AND ORGANIZATIONS SUPPORTING THE PROTECTION OF ECOSYSTEM RESOURCES (PROSPER)

BIOMONITORING HANDBOOK FOR COMMUNITY FORESTRY IN LIBERIA

DISCLAIMER
The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

TABLE OF CONTENTS

TABLE OF CONTENTS ..... **I**
ACRONYMS AND ABBREVIATIONS ..... **III**
1.0 INTRODUCTION **1**
2.0 DESIGN OF BIOMONITORING PROGRAM **3**
2.1 GENERAL APPROACH 3
2.2 PERSONNEL ORGANIZATION 4
2.2.1 Program Coordinator 5
2.2.2 Field Assistant 5
2.2.3 Field Team 6
2.3 EQUIPMENT AND MAINTENANCE 7
3.0 IMPLEMENTATION **8**
3.1 STEP 1: DESIGN LAYOUT OF TRANSECT SYSTEM 8
3.1.1 How to Design the Layout of Your Line Transect System 9
3.2 STEP 2: ESTABLISH TRANSECT LINES IN THE FIELD 29
3.2.1 How to Navigate around an Obstacle? 31
3.3 STEP 3: HABITAT DESCRIPTION OF TRANSECT LINES 34
3.3.1 Explanation 34
3.4 STEP 4: SET-UP AND OPERATION OF WEATHER STATION 37
3.4.1 Set-Up of Weather Station 37
3.4.2 Recording of Weather Data 39
3.5 STEP 5: DATA COLLECTION PROTOCOL 39
3.5.1 Explanation 41
3.6 STEP 6: DATA STORAGE AND MANAGEMENT 48
3.7 STEP 7: DATA ANALYSIS AND REPORT 53
3.7.1 Weather Data 53
3.7.2 Biomonitoring Data 55
3.7.3 General Guidelines for Biomonitoring Report 61
4.0 ADD-ONS AND ALTERATIONS OF THE PROTOCOL **64**
4.1 DISTANCE SAMPLING 64
4.1.1 Explanation 66
4.1.2 General Notes on the Measurements 67
4.1.3 Measurement of Direct Observations (SEE) 68
4.1.4 Measurement of Dung (DUN) 69
4.1.5 Measurement of Chimpanzee Nests (NES) 71
4.2 BOTANICAL MONITORING 74
4.2.1 General Background 74
4.2.2 Indicator Species 75
4.2.3 Phenological Monitoring 76
4.2.4 Growth, Recruitment and Mortality Rates 77
4.3 HARVESTING PRACTICES AND LEVELS 77
4.3.1 Interviews 78
4.3.2 Field Surveys 78

5.0 TRAINING MODULES 79
5.1 GENERAL OVERVIEW 79
5.1.1 Target Group 79
5.1.2 Content and Methodology 79
5.1.3 Participants 80
5.1.4 Training Materials 80
5.1.5 Venue 80
5.1.6 Opening/Registration 80
5.1.7 Ground Rules 80
5.1.8 Presentation 81
5.1.9 Evaluation 81
5.2 MODULE 1 81
5.3 MODULE 2 86
REFERENCES 90
ANNEX 1: LIST OF EQUIPMENT 92
ANNEX 2: DATA COLLECTION SHEETS 94
ANNEX 2A: HABITAT DESCRIPTION FORM 95
ANNEX 2B: WEATHER DATA RECORDING SHEET 97
ANNEX 2C: BIOMONITORING DATA COLLECTION SHEET 98
ANNEX 2D: DISTANCE SAMPLING DATA SHEET 99
ANNEX 3: FAUNAL INDICATOR SPECIES LIST 100
ANNEX 4: TRAINING MANUALS 102
ANNEX 4A: TRAINING MANUAL MODULE 1 103
ANNEX 4B: TRAINING MANUAL MODULE 2 150

ACRONYMS AND ABBREVIATIONS

CI	Conservation International
FDA	Forestry Development Authority
FFI	Fauna and Flora International
IUCN	International Union for the Conservation of Nature
LFSP	Liberia Forestry Support Program
LISGIS	Liberian Institute of Statistics and Geo-Information Services
LRCFP	Land Rights and Community Forestry Program
PROSPER	People, Rules and Organizations Supporting the Protection of Ecosystem Resources
SNP	Sapo National Park
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

1.0 INTRODUCTION

To build on previous investments in the forestry and agricultural sectors, particularly the Land Rights and Community Forestry Program (LRCFP, 2007-2011) and the Liberia Forestry Support Program (LFSP, 2011-2012), USAID contracted Tetra Tech in May 2012 to implement a new, five-year program (2012-2017) entitled People, Rules and Organizations Supporting the Protection of Ecosystem Resources (PROSPER). The overall goal of the program is to introduce, operationalize and refine appropriate models for community management of forest resources for local self-governance and enterprise development in targeted areas of the country. In total ten community forest sites (henceforth also CF sites) were selected; eight in Nimba and two in Grand Bassa County (USAID 2012a). The project includes a strong biodiversity conservation component, and requires that PROSPER activities directly address threats to biodiversity. Liberia contains an estimated 42% of the remaining Upper Guinean Rainforest, and was identified as the top priority country in humid West Africa from a conservation perspective (CONSERVATION INTERNATIONAL 2001). Home to more than 2,000 vascular plant species, approximately 125 terrestrial mammal species, 590 bird species, 74 known reptiles and amphibians and over 1,000 described insect species, Liberia's forests also provide one of the last strongholds and the best chance of survival for several globally threatened species, including the West African Chimpanzee (*Pan troglodytes verus*), Western Red Colobus (*Procolobus badius badius*), Pygmy Hippopotamus (*Choeropsis liberiensis)* and Jentink's Duiker (*Cephalophus jentinki*). However, Liberia's rich biological diversity is threatened by human activity at different levels, and its long-term future will depend on the continued existence and proper management of resources. The PROSPER project will establish a community-based biomonitoring program in all selected sites, which furthermore could serve as a general model for community forestry in Liberia.

Biomonitoring, if carried out appropriately, is considered an effective tool for the proper management of natural resources, and is globally applied in many fields and protected areas. It not only provides essential knowledge on biodiversity in a given area, but also helps to identify and monitor threats to the ecosystem, and therefore can enable managing authorities to take appropriate measures. While monitoring programs are based on the same underlying principle, to monitor certain indicators over time, specific methodologies of the respective approaches depend on site-specific objectives and purposes. The biomonitoring program presented in this handbook was specifically designed to meet the requirements of a community-based monitoring program applied in community forests such as the PROSPER CF sites. The overall goal is to monitor and evaluate the impact of PROSPER interventions on the site's vulnerable biodiversity. The program should serve as a tool to inform the sustainable management of the forest resources by the communities, and hence a main focus is the monitoring of human impacts such as farming, hunting and chainsawing, which were identified as primary threats at the respective sites (USAID 2012b). The program does not claim to produce detailed, scientific data on plants and animals, which would require a more complex methodology, equipment and additional budgetary and human resources. In order to be both effective and "user-friendly", the approach further needed to be kept comparatively simple, not only with regard to the expectable education level and skills of key staff, but also in view of (locally available) materials and equipment. Since the communities in the long-term should be able to run this program independently, the creation of unnecessary dependencies should be avoided right from the beginning. The biomonitoring program design considers and combines elements of various approaches, mainly but not exclusively derived from FFI's long-term biomonitoring program in Sapo National Park (e.g. WAITKUWAIT AND SUTER 2003; VOGT 2011), as well as the biomonitoring program that was established by CI in Nimba under the LRCFP (USAID 2011).

The handbook is split into four main parts:

1) A general description of the design is given in Chapter 2
2) The main steps of implementation are presented in Chapter 3
3) Examples for potential extensions of and add-ons to the basic protocol are outlined in Chapter 4
4) Training Modules are provided in Chapter 5

2.0 DESIGN OF BIOMONITORING PROGRAM

2.1 GENERAL APPROACH

The community-based biomonitoring program will be carried out using line transect sampling, a widely applied standard method for multi-species and human impact monitoring in African Rainforests (e.g. WHITE AND EDWARDS 2000; KÜHL ET AL. 2008; MAISELS AND ABA'A 2011). A transect is a straight line of various length heading into a predetermined direction. A permanent transect system will be established in each CF site; the number and length of lines will depend on the size of the area and is outlined more in detail in section 3.1 below. In contrast to "one-off" transects, which are surveyed only once as for example in a species census, permanent transects are repeatedly used and therefore maintained in a certain way. This will include markings as well as regular clearance of re-growing vegetation. Further, a general habitat description of each line should be in place before starting the actual monitoring. Data collection along the transects will be carried out at least once a year, but if resources allow (also taking into account the need for data analysis), it is advisable to conduct both one survey in the dry season and one in the wet season. Each transect line will be monitored once annually during a daytime survey. Given the scope and main objectives of the monitoring program, data collection along the transects will focus on two main data sets: (i) all types of human impacts (including hunting, farming, mining, logging and harvesting of non-timber forest products [NTFP]), and (ii) a subset of faunal indicator species, which are selected based on the following criteria: species that are subject to anthropogenic pressure (e.g. through hunting, habitat destruction and fragmentation), species of conservation concern (indicated by IUCN status) and species that are easy to recognize, identify and monitor by the local communities. These features mainly apply to large-medium sized mammals such as primates, ungulates and carnivores, as well as several hornbills and a few reptiles (see proposed list in Annex 3). The two data sets are considered most suitable both in view of their information value for the CF management units and practical aspects, as they can be relatively easily and accurately recorded. The protocol will further include basic phenological data, that is ad-hoc observations on fruiting and flowering trees along the transects, to better understand ecological factors such as variations in spatial distribution of the selected animal species. The results generated by line transect data include presence/absence, indices of abundance and spatial distribution of animal species and human activities, and, if repeated over time, trends of these parameters. The addition of a more complex variation of the basic line transect sampling, called Distance Sampling (BUCKLAND ET AL. 2001), would allow for generation of population density estimates of selected faunal key species, for example chimpanzees and elephants. This approach however poses some challenges, as it requires very thorough recording, including precise distance measurements, a certain sample size, as well as extensive data analysis. Hence it is not really suitable for the envisaged straightforward sampling protocol. The monitoring of trends in animal populations does not necessarily require the knowledge of the total population size in a given area, but uses relative abundances such as encounter rates as monitoring tool. The general protocol thus will not require distance measurements. Nevertheless, the Distance Sampling recording method will be introduced in this handbook too, so that in case of a site-specific interest in this information, it can be added to the basic protocol. Apart from the need for accuracy and some additional

equipment, the data collection itself does not entail a tremendous increase of survey effort. As the field teams are collecting data in the field, they could record these additional data, which then could be stored and kept for future analysis by researchers or students.

The overall approach of the monitoring program does not foresee detailed botanical monitoring. Long-term surveillance of vegetation parameters is indicated for example in the interest of determining changes of plant community composition over time, forest regeneration and annual growth and mortality rates, monitoring of invasive plant species etc., aspects, which are not the direct target of the community monitoring program (but see below). Threats to the floral diversity in the community forests are mostly caused by farming and timber extraction, and probably by overharvesting of (specific) NTFPs (USAID 2012b). These parameters will be covered by the human impact monitoring. However, since the project might foresee the commercialization of certain forest products, a site-specific interest in including botanical features in the monitoring program may arise. In that case, the transects could be used at the same time as botanical sampling plots or strips, and the floral data collection combined with the common protocol. Some relevant examples will be outlined in Chapter 4. Yet it has to be kept in mind that the monitoring of vegetation parameters can be quite complex, and might require additional expertise, training, equipment and manpower. Since it would go beyond the scope of this handbook to expand upon these approaches and methods, the proposed add-ons in Chapter 4 will provide a more generalized description, and references to relevant literature.

Since the transect system will be evenly distributed across the forest and thus cover a large area, the biomonitoring field work could, in principle, serve at the same time as a patrol. This however will depend on the purpose and extent of patrolling activities in a given CF site. If patrols are primarily for recording human impacts, without direct follow-up on site by chasing hunters or destroying trapping lines etc., then the biomonitoring protocol already includes the patrolling aspect. Otherwise, since the biomonitoring field teams have to focus on their protocol rather than being distracted by other, additional duties, it is neither recommendable nor feasible that the same team carries out both tasks simultaneously. Moreover, patrols will need to be repeated more frequently than the biomonitoring data collection. Still, due to logistical advantages, biomonitoring and patrolling operations certainly could be combined, and patrol units are encouraged to use the transect system, as long as they don’t disturb or interfere with the biomonitoring data collection. This means that if patrols and biomonitoring occur on the same days, patrol units should not use any transect line before the biomonitoring data collection had been completed along that particular line.

A simple weather station should be set up at each CF site. Due to the civil unrest, weather data of the recent past in general are lacking for Liberia. These data however are important, among others to better understand ecological interrelations and therefore help with the interpretation of survey results. Basic parameters such as temperature, humidity and rainfall are relatively easy to monitor and don’t necessarily require sophisticated high-tech tools.

2.2 PERSONNEL ORGANIZATION

The following core staff is recommended for running the biomonitoring program:

- A Program Coordinator
- A Field Assistant, supporting the Program Coordinator
- Field Teams of 6 community members each (1 team leader and 5 trackers)

The number of staff per position will depend on the extent of the overall program, such as the number and size of sites, the distance between the sites etc. It may be sufficient to appoint one Program Coordinator for the whole program, while it is recommendable to have one Field Assistant and at least one Field Team

per site. Their roles and responsibilities are outlined below. In general changing staff over time should be avoided, as this usually causes problems and weakens the program. The teams will not only be intensely trained and therefore acquire important knowledge, but they will also develop a strong team spirit and act as good working units. Further, in order to ensure the consistency of data collection and analysis, unnecessary variations between surveys should be avoided. In other words it is essential to keep as many factors constant over time as possible; for example the surveys should always be carried out at the same time of the year, and preferably by the same data recording team.

2.2.1 PROGRAM COORDINATOR

The Program Coordinator will have overall supervision and responsibility for the proper implementation of the program. The program requires sound management including not only a good understanding of biomonitoring, but also strong organizational and communication skills. The coordinator will train the field staff and supervise initial field work, while the field teams should be able to carry out the data collection by themselves. S/he further will be responsible for the data analysis, report writing and sharing results with the CF management units, in order to take appropriate measures with regard to the sustainable use of forest resources as agreed with the communities. Given the required skills and qualifications, a person with a background in forestry and/or conservation biology, for example a Forestry Development Authority (FDA) staff or graduate forestry student, should be appointed to this position.

Box 1. Main responsibilities of the Program Coordinator

- Initiate and establish biomonitoring program at CF site(s)
- Train field staff
- Planning, organization and coordination of field trips together with field staff
- Join initial field trips to ensure correct implementation
- Oversee and arrange equipment
- Data entry and management
- Data analysis
- Production of the annual report
- Presentation of results and annual report to CF management units
- Based on results, discuss appropriate measures with CF management units

2.2.2 FIELD ASSISTANT

The Field Assistant will support the Program Coordinator specifically with the practical implementation of the program in the field. S/he will act as a facilitator on site, similar to the PROSPER community mobilizers. The assistant's responsibilities involve close cooperation with the communities, planning of and occasional participation in the monitoring field work, and ensuring that required items are in place. S/he will also provide and collect and check the data collection sheets, respectively, and assist the Program Coordinator with the data entry. This position thus requires strong organizational skills as well as basic computer knowledge. It could be filled by either the community mobilizers or a student or project intern.

Box 2. Main responsibilities of the Field Assistant

- Facilitate Program Coordinator's field operations
- Planning, organization and occasional participation in field work
- Submit a list of required items (food, equipment etc.) to the Program Coordinator on time
- Together with Field Team Leader(s) supervise proper use and maintenance of equipment
- Provide data sheets to the teams
- Check and control filled data sheets and medical log sheets
- Assist Program Coordinator with data entry

2.2.3 FIELD TEAM

A field team may comprise six staff—two for keeping the camp and four trackers for data collection along the transects. They should come from the local communities and comprise hunters, who are experienced in identifying animal signs. One of the team members will be assigned as Team Leader, and will be responsible for overseeing and managing the field work. His/her responsibilities include the planning of field trips together with the Field Assistant, assigning the team members to their specific tasks, leading on the data recording, controlling the handout of medicine and proper management of equipment. The Team Leader further should keep a field diary and produce a short report after each field survey, including basic information such as dates, participants, daily operations and specific observations. The trackers together with the Team Leader will survey the transect lines and ensure correct data recording and identification of animals signs. They will also be responsible for the establishment and maintenance of the transects. The persons assigned to stay in the camp need to cook, collect firewood, manage the food, dry clothes etc. All team members must ensure the proper maintenance and responsible handling of all equipment.

Box 3. Main responsibilities of the Field Team

Team Leader

- Plan, organize and coordinate field trip together with Field Assistant
- Supervise field work, assign team members and manage camp life
- Ensure accurate data collection
- Control and handout of medicine of the First Aid Kit
- Keep a field survey diary and write a short report after each field trip
- Manage and ensure proper handling of team equipment
- Hand-over of data sheets, photographs and report to Field Assistant

Trackers / Other team members

- Follow instructions of and support Team Leader
- Support accurate data collection, identify animal signs etc.
- Establish and maintain transect lines
- Camp keeping and cooking, etc.
- Proper and responsible handling of equipment

In view of PROSPER's gender strategy (USAID 2012c), it has to be mentioned that women theoretically could form part of the Field Team, for example be responsible for filling the data sheet or keeping the camp and cooking. However, from a practical point of view, this might imply some complications. Usually all field team members use one tarpaulin tent for sleeping, but since men and women cannot share the same sleeping place, additional equipment needs to be carried be to the field, which in turn might require additional porters. In addition there might be other issues restricting women from

participating in multi-day field trips, such as household chores, child care, farm work, as well as moral aspects or cultural assumptions about a woman's role in the community.

2.3 EQUIPMENT AND MAINTENANCE

A detailed list of all equipment that is required for the implementation of the program is provided in Annex 1. This section deals with some general aspects and recommendations for its proper handling and maintenance.

The items issued for biomonitoring operations should not be considered as personal effects, but are the property of the project. They comprise a number of expensive and/or vulnerable devices such as GPS and cameras etc. It is the responsibility of all biomonitoring staff to handle all issued items cautiously and only for biomonitoring operations. The Team Leaders and Field Assistants will be appointed for the overall control and management. There will be two main categories of equipment: (1) team equipment, which includes all items that are used together by the team during field work (e.g. GPS, binoculars, camping equipment etc.), and (2) individual equipment such as backpacks, sleeping bags, rain gear, flashlights etc., which will be issued to every single team member. It is recommended that all items, both the team and the individual equipment, are collected after each field trip and stored at the PROSPER field office. Otherwise it will be difficult to control and avoid personal use by the community members between the surveys, for example for farm work or other private purpose. The Team Leaders and Field Assistants should keep a store accounting, that means a list of all equipment, and record the date of issuance and receiver, date of return, any damage etc. Upon completion of field work, the team members must clean and dry the equipment, hand it over to the Team Leader and immediately report any loss or damage. The Team leader will take notes and transfer the materials over to the Field Assistant. Both should complete the list and check if items need to be replaced for the next trip. It is recommended to establish a fixed issuance scheme, which may further improve cautious handling and long-lasting of equipment. Some items may be more robust and/or more often used than others, and thus worn out at different frequencies. Backpacks, sleeping pads and sleeping pads for example will not need to be replaced as often as flashlights or rainboots. A reasonable issuance scheme further means that items are not issued on need, but expected to last for a certain time and therefore will urge people to pay particular attention to the supplies entrusted with them. Annex 1 contains some suggestions on replacement frequencies, which, based on experience from other programs, should serve as general guidance, but will allow for flexibility.

3.0 IMPLEMENTATION

This chapter comprehensively describes the steps for the practical implementation of the biomonitoring program, starting from its initial design to the production of a final (annual) report. The overall lead on the implementation is the responsibility of the Program Coordinator. Most steps, however, will involve the field staff, who must be trained on variety of topics prior to the execution of the respective tasks. Due to a number of reasons such as logistics, it is recommended that several training topics to modules be combined rather than carrying out many single training lessons on every single step. The required training therefore is not listed as its own step in this chapter, but will be handled separately in Chapter 5.

3.1 STEP 1: DESIGN LAYOUT OF TRANSECT SYSTEM

As a rule of thumb, approximately 50 transects of 2 km length each must be performed for an area of 100,000 ha, to get a representative sample of the site. This however applies predominantly to large areas of 50,000 ha and beyond, and cannot just simply be broken down for smaller areas (which would imply that one transect line would sufficiently cover an area of 2,000 ha). In general there should be a minimum of at least 5 to 10 transect lines per site. For very small areas their length could be less than 2 km, for example 500 meters or 1 km. The following guidance is given for the particular PROSPER CF sites:

- Sayee CF: 5 – 10 lines of 500 m
- Barconnie CF: 5 – 10 lines of 1 km
- Kortor CF: 10 – 15 lines of 2 km
- Gblor CF: 10 – 15 lines of 2 km
- Big Gio CF: 25 – 30 lines of 2 km

In order to be representative of the study area as a whole, transect lines must not be intentionally located, as for example for reasons of convenience close to roads, but follow certain rules of sampling design. They should be placed more or less randomly and further cut across the major drainage features of the area. That is, the direction of the transect lines should run approximately 90° (perpendicular) to the larger streams and rivers and mountain ridges. A common approach, which will also be used in this handbook, is the so-called "systematic, regularly spaced sampling with random starting point"-model, which will produce a fairly representative sample even though it is not completely random (e.g. WHITE AND EDWARDS 2000; BUCKLAND ET AL. 2001; THOMAS ET AL. 2009). It has the advantage that it is generally easier to locate lines which are evenly distributed than to locate them entirely randomly across the study area. The layout will be created with the computer program DISTANCE (BUCKLAND ET AL. 2001; THOMAS ET AL. 2009), which, based on certain parameters determined by the researcher, will calculate the geographic coordinates of the starting and ending points of the transect lines in the particular CF site. The DISTANCE program (currently version 6.0 Release 2) including the user's guide is available for free download on http://www.ruwpa.st-and.ac.uk/distance.

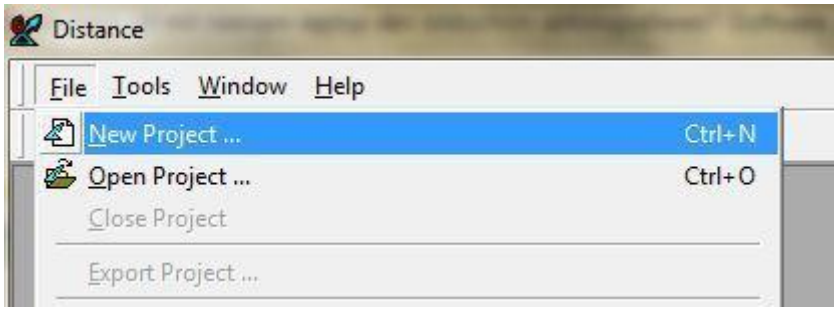
It further requires the coordinates of the boundaries (in **UTM** format) of the CF site, and hence probably requires assistance from a GIS specialist. An elaborate instruction on how to create the design is outlined in the DISTANCE user's guide, and also given for example by the Great Ape Section (SGA) of the IUCN/SSC Primate Specialist Group (MAISELS AND ABA'A 2011), which is available on the web as well (search for "*IUCN SGA Monitoring Section 3 Survey design for web pdf*"). There are several ways to

import/export geographic data into/from DISTANCE, most commonly by using GIS software such as ArcGIS. However, since the Program Coordinator most probably will not have this software, or the knowledge of how to use it, a simpler version is outlined in this handbook. The steps will be explained below, based on an example for Sapo National Park, and require the following:

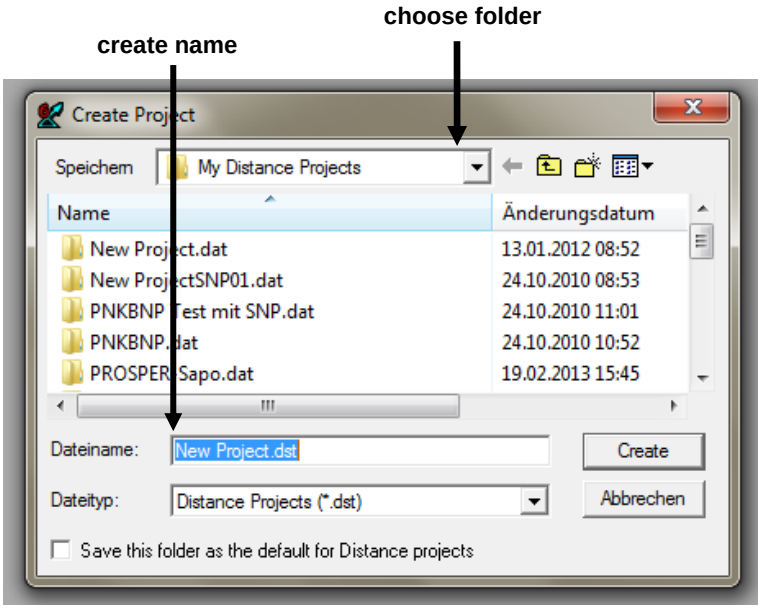
- DISTANCE 6.0 software is installed on the computer
- GIS data (coordinates) of the boundaries of the CF site in UTM format. If the coordinates are in another projection (usually Geographic), they must be re-projected in UTM. They should be provided by PROSPER or might also be available from FDA or LISGIS.
- GARMIN BASECAMP 4.1.1 software is installed on the computer. This program is needed to transfer GPS data from the computer to the GPS and vice-versa, and usually comes with every Garmin GPS. Otherwise it can be downloaded for free from the Garmin website: http://www.garmin.com/en-US/shop/downloads/basecamp

3.1.1 HOW TO DESIGN THE LAYOUT OF YOUR LINE TRANSECT SYSTEM

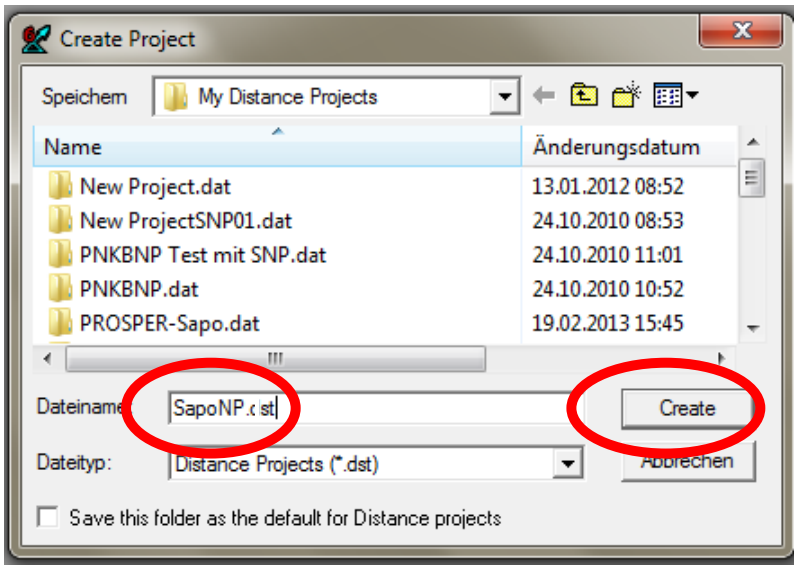
1. Open the DISTANCE program. Click on "File" and then choose "New Project".



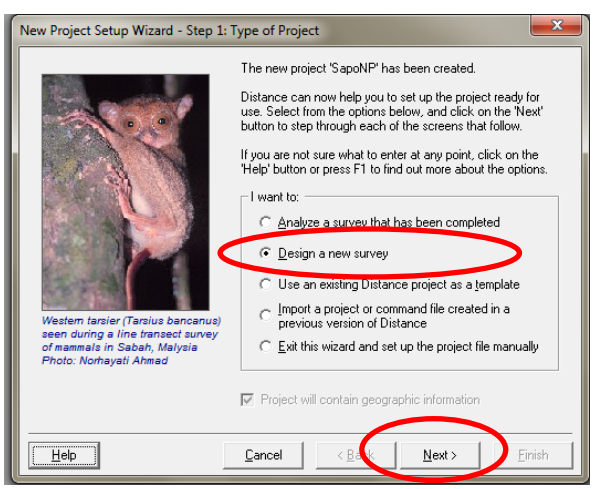
2. The following dialogue box will open. First choose the folder where you want to save your design. In the example below it is the folder "My Distance Projects". Second, give your project a new name, use the name of your study site (in our example Sapo NP; second picture below).

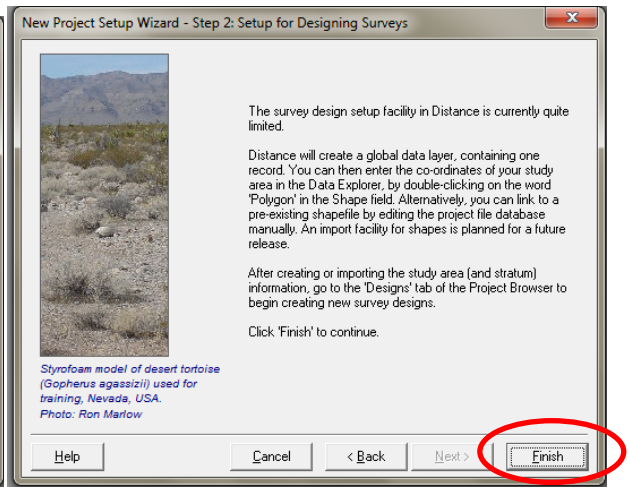


The file name is then “SapoNP.dst”. Confirm your name by clicking “Create”.

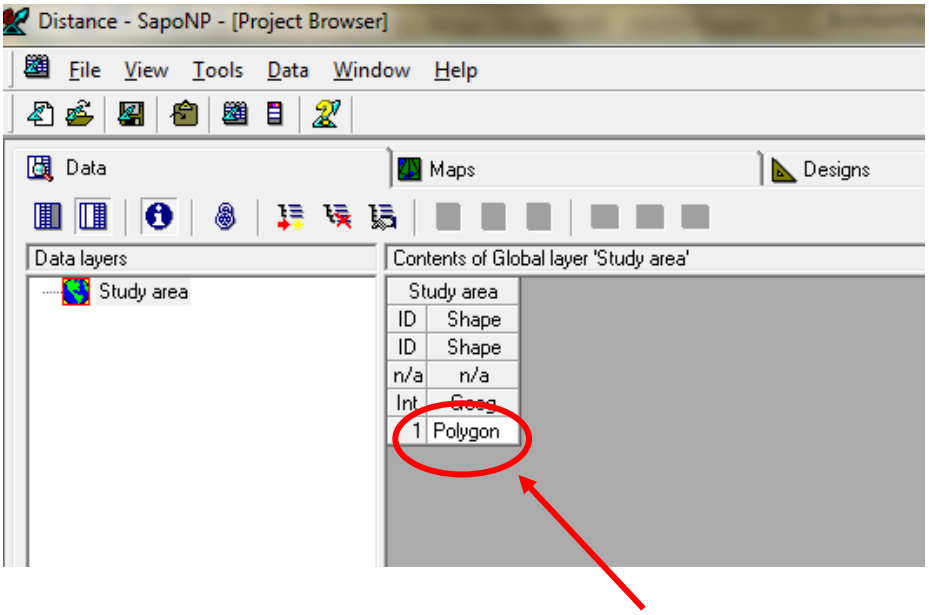


3. A new dialogue box will open (below, left). Choose the “Design a new survey”, then click on “Next”. A new dialogue box will open (below, right); click on “Finish”.

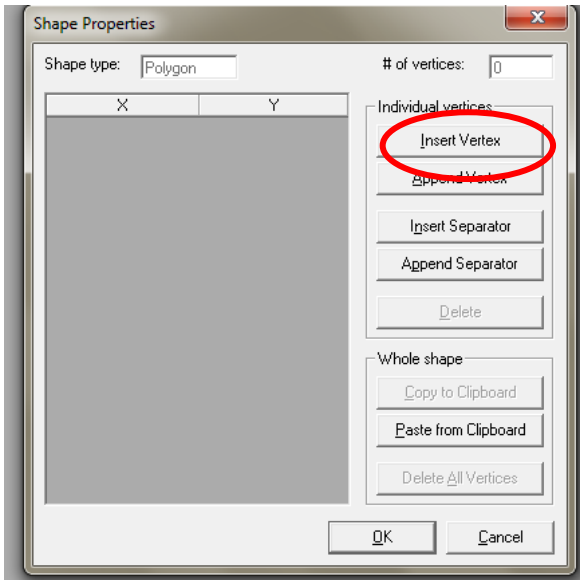


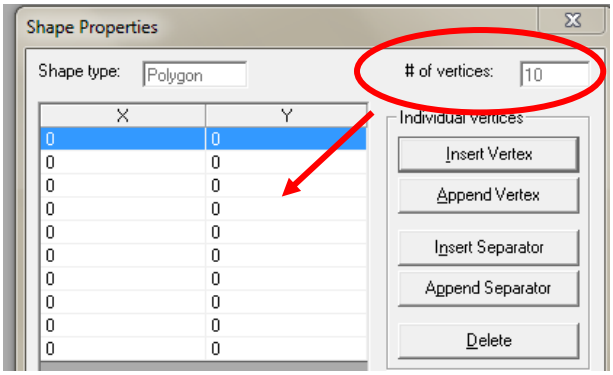


4. Next you will see this. You now have to import the coordinates of your study area into DISTANCE. There are two ways to do this without using ArcGIS: a) they can be typed in manually, which might be feasible if there is only a limited number of coordinates, or, in case there are too many b) they can be copied from a Word-document or a text file. Both ways will be explained.

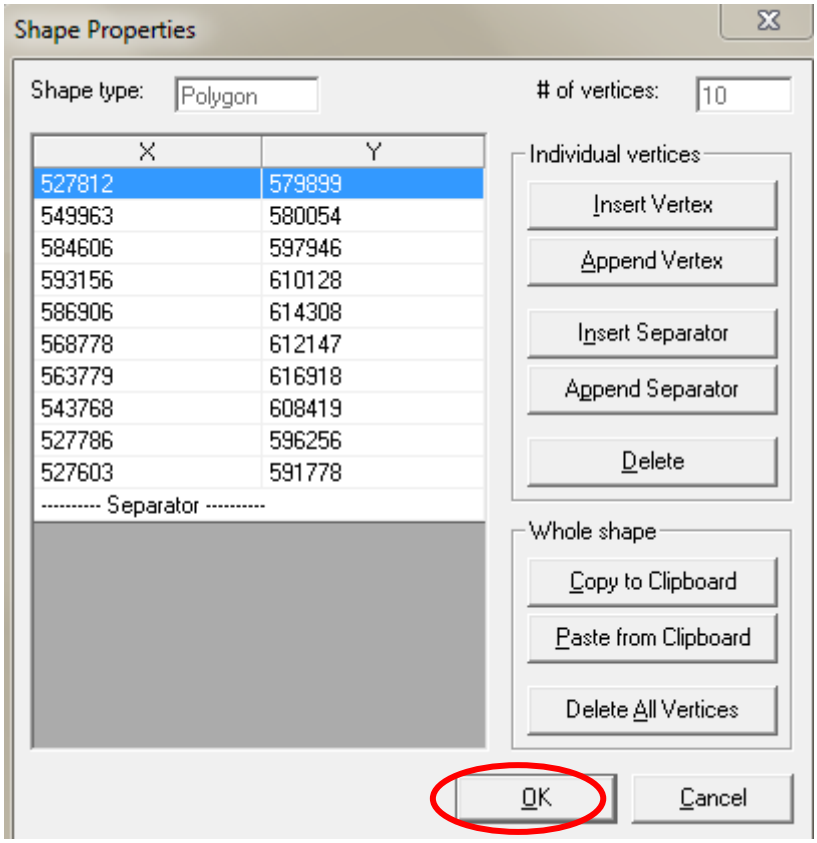


a) To import coordinates manually, double click on the "Polygon". The following dialogue box will open (left picture below). Click on the button "Insert Vertex"; this will create a line below the X and Y columns and allow entering your coordinates (right picture below). Add as many lines you need (corresponding to the number of coordinates) by repeatedly clicking the "Insert Vertex" button. In our example below there are 10 coordinates defining the boundary line of Sapo NP, so ten lines were created.





Now click the respective cells to enter the X- and Y-coordinates manually (example see picture below). When you have finished click “Ok”.



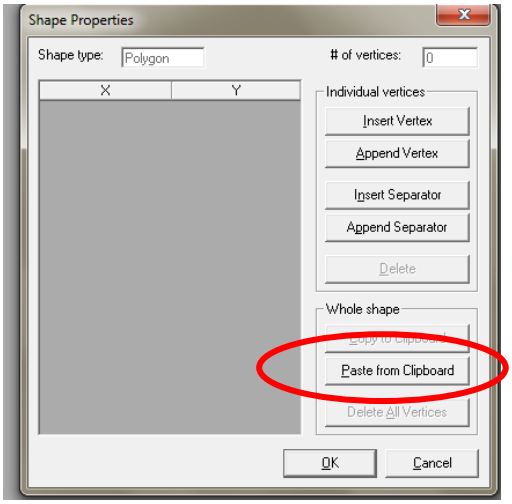
b) If coordinates should be copied from a word document or text file, they have to be in the format “X-coordinate tab Y-coordinate”. It means that there has to be a space character between the two coordinates, as shown here for an example of the first three Sapo NP coordinates:

527812 579899

549963 580054

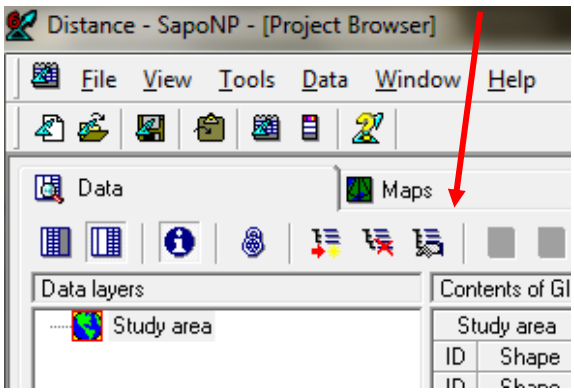
584606 597946

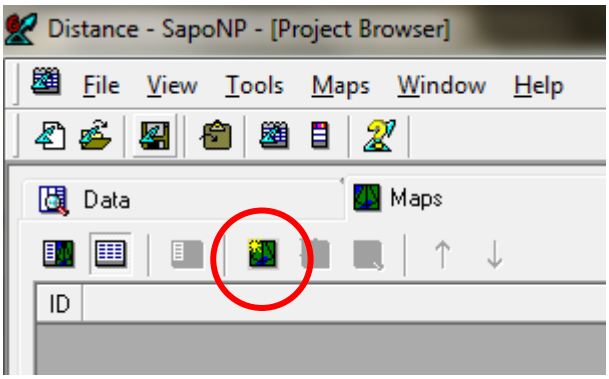
Open the Word document (or text file) which contains the coordinates of the CF site. Highlight all data (mark them) and copy them. (As long as you don't paste them anywhere else, they will be stored virtually on the Windows Clipboard). Switch back to DISTANCE and double click on "Polygon" as explained under a), which will lead to open the following dialogue box. Click on "Paste from Clipboard".



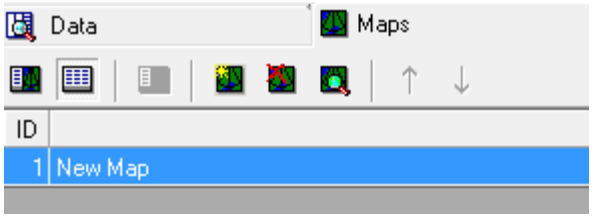
The X and Y columns should now contain the rows you copied from the Word document, and the top right hand window that says "# vertices" should now read the number of coordinates you have pasted in (in our example 10 as shown in the bottom figure under a) above). Click "Ok" and the dialogue box will close.

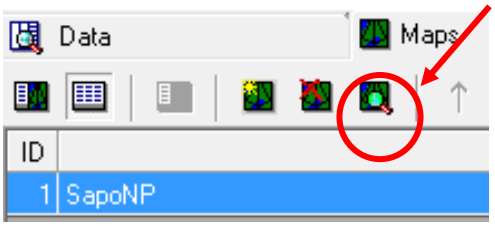
5. Now click on the "Maps" tab (left picture) and then on the icon "New Map" (right picture).



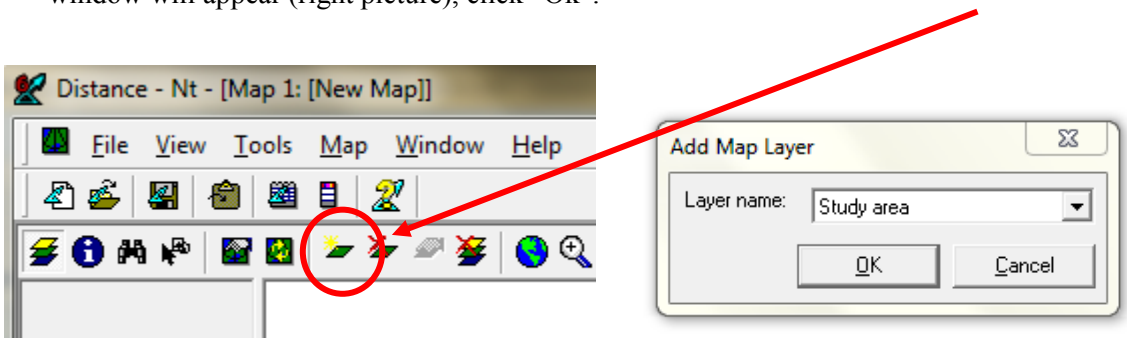


The following will appear (left picture). Double-click on "New Map" to give the map a name (of your CF site; in our example Sapo NP, right picture). Next click on the icon "View Map"

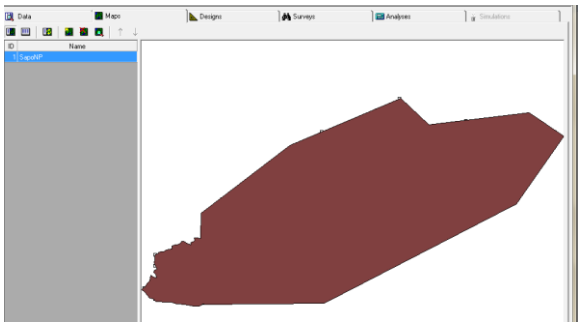




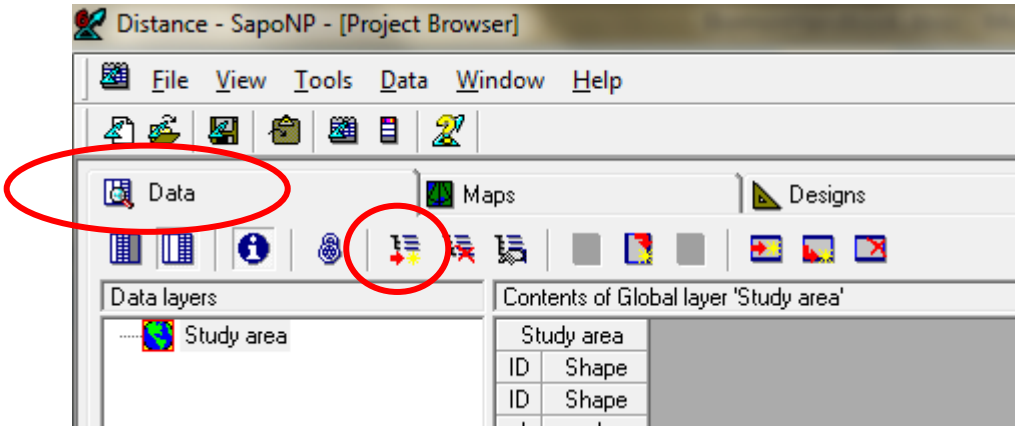
6. The following blank Map window will appear (left). Click the icon “Add layer to Map”. Another window will appear (right picture), click “Ok”.



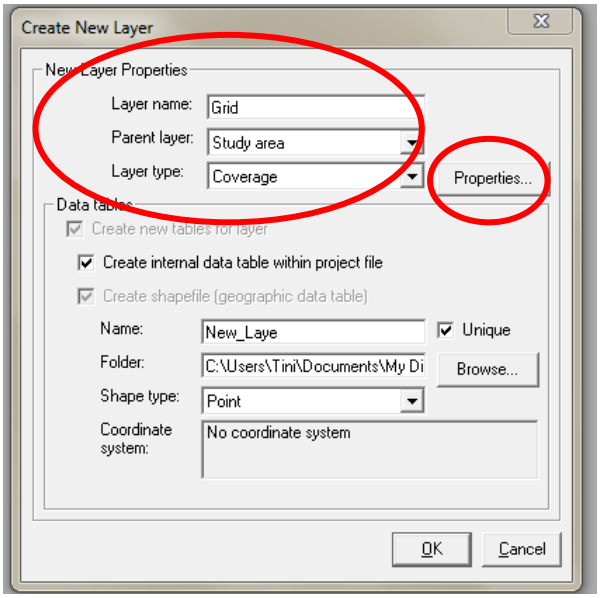
7. You now should see a map of your study area, as indicated below for Sapo NP.



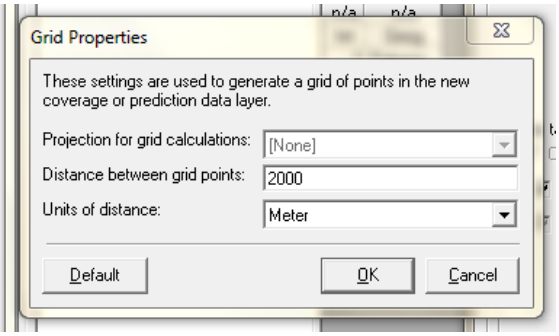
8. Before the actual transect layout can be created, it is still necessary to add a so-called coverage layer to the map. Click on the “Data” Tab and then on the icon “Create New Data Layer”.

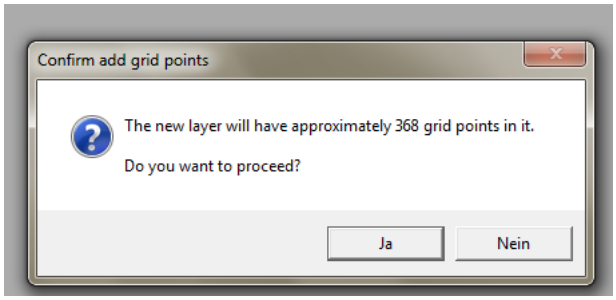


The following window will pop up. Under “Layer name” type Grid and under “Layer type” choose “Coverage”. Next click on the “Properties” button on the right.

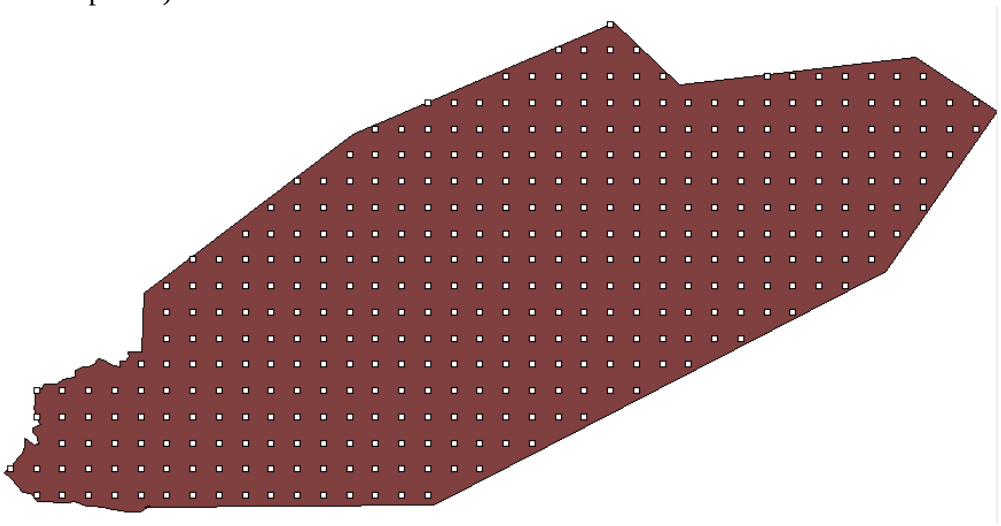


9. The “Grid Properties” window will open and you have to set the Unit, which should be meter, and the Distance between the grid points (left picture below). The distance will depend on the size of your study site, and the number of and spacing between transect lines. As a rule of thumb orientate yourself either on the desired spacing between transects or the length of your lines. For Sapo NP it was set at 2000 meters (left picture). When you click “Ok”, the program will inform you on how many grid points will be created by your settings. For Sapo, with the distance of 2000m, it resulted in 368 points (right picture). There should be at least several hundred points in total, so you might have to do trial and error in order to get this right. Finally, if you agree with the number, confirm to proceed.



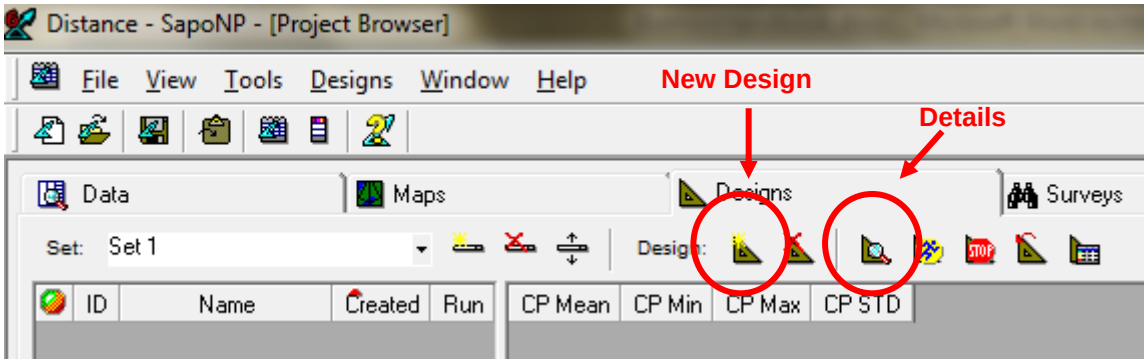


10. You can now view the coverage grid on your map. Click on the “Map” Tab, choose “View Map” and then “Add Layer” (similar to what was explained under Step 5 and 6 above). Now the Layer name will be “Grid”. Click “Ok” and you should see the grid points superimposed on the map (below the example for Sapo NP).

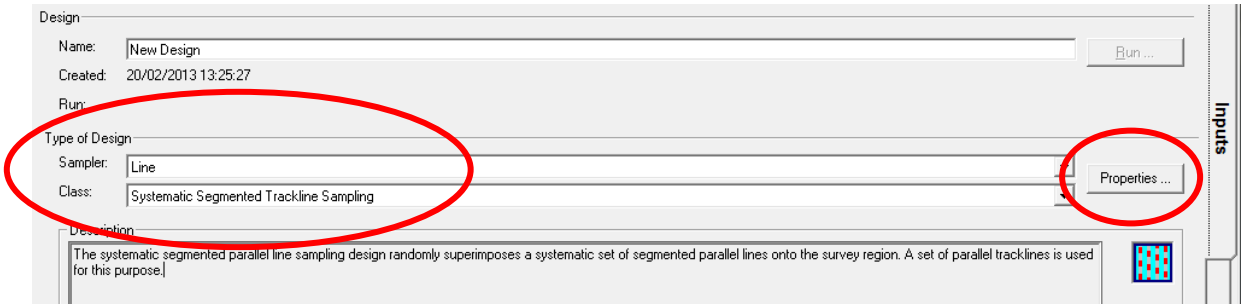


Close the Map window and confirm the changes in your map. You now can create the layout of the transect lines.

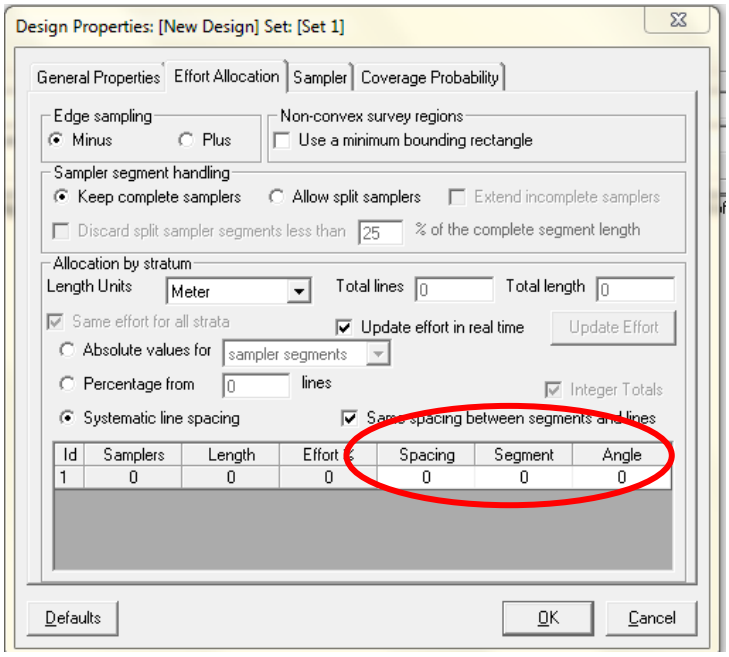
11. Click on the “Designs” Tab (this is the one right next to the Maps Tab), which looks like this. Click the icon “New Design”, and then on “Show details for selected design”.



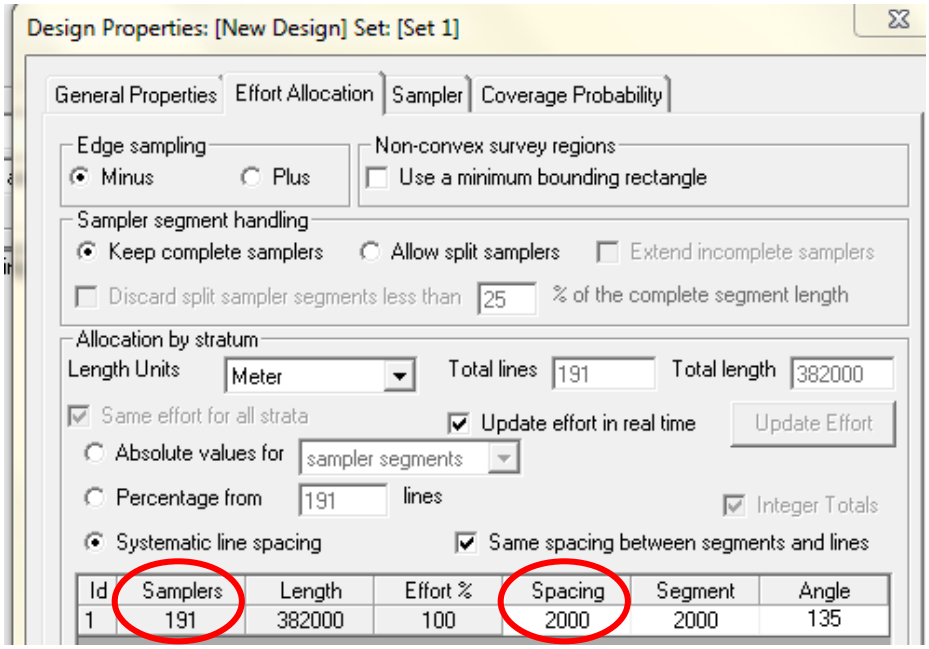
12. In the now appearing window, under Type of Design, choose “Line” and “Systematic Segmented Trackline Sampling”.

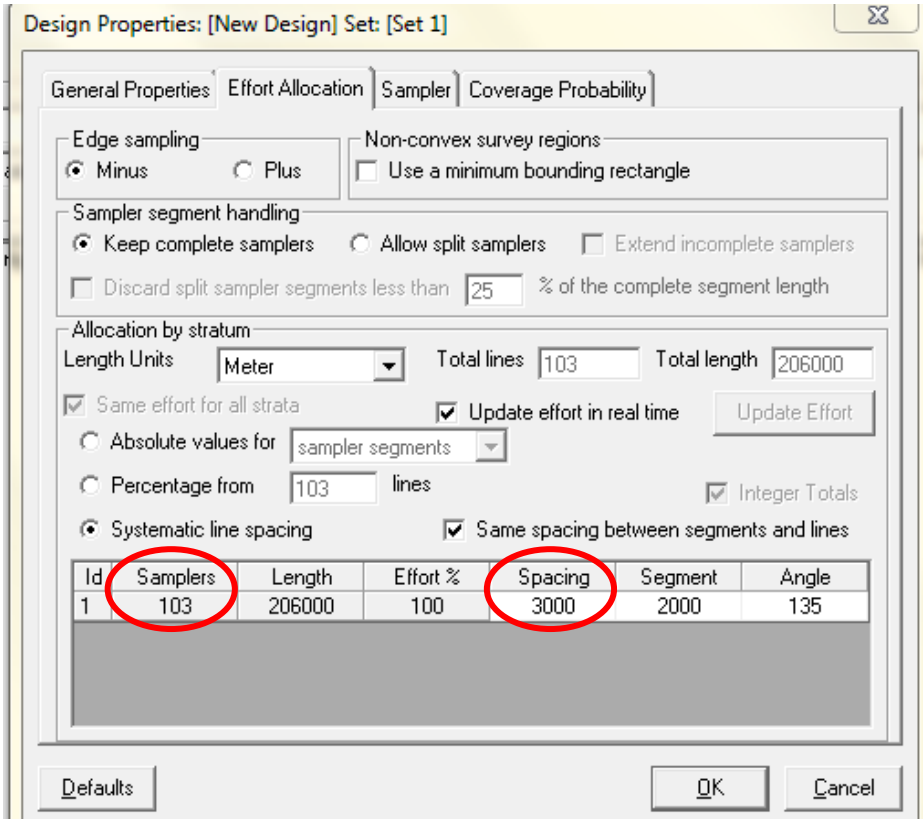


13. Next, in the same window, click the button “Properties” on the right to define the details of your design, such as number and the length of and the spacing between your transect lines, as well as their orientation. These parameters will depend on the respective CF site. Choose the various units and values for your survey design. You should have an idea of approximately how many transect lines you want to establish in the CF site, their length and orientation (e.g. perpendicular to the main drainage pattern of the area). As soon as you click the “Properties” button, the following window will pop up. You have to go to the “Effort Allocation” Tab. Make sure that the settings are selected as in the picture below (e.g. Edge Sampling set on “Minus”, Sampler segment handling “Keep complete samplers”, etc.). These general settings will be the same for all CF sites. Only the three parameters “Spacing”, “Segment” and “Angle” in the last row (marked by the red circle) need to be set specifically, depending on your CF sites’ desired features. “Spacing” refers to the minimum distance you want to keep between two transect lines. As a rule of thumb the spacing between lines (both laterally and successively) should be at least 250 meters. Enter the value in meter (because the Lengths Unit is also set to meter). “Segment” refers to the length of the transect line, enter it again in meter. The angle has to be set in degree (i.e. if the transect lines should run North-South you would enter 0, if they should run from West to East you would enter 90). As soon as you are making entries in these cells you will see that the number in the left cell “Sampler” will change automatically. This indicates the number of transects the program would generate with your settings. In order to get approximately the targeted number of transects you might have to play a bit with the “Spacing”. In general it is advisable to create a few more transects than you will need, because some lines created by DISTANCE in reality might lie in or cross inaccessible areas such as rivers, and therefore cannot be established. So you will need some alternative transects.

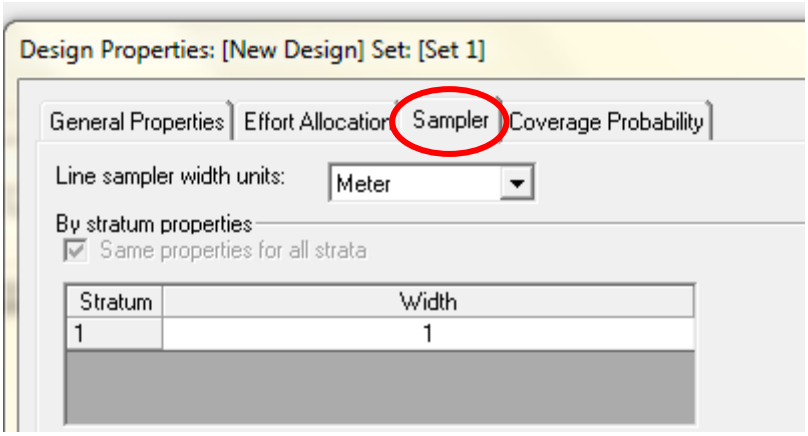


In our example for Sapo NP (see pictures below), we want to create approximately 100 lines with a length of 2 km each, with an angle of 135 degrees. The spacing between two lines should be at least 500m (for this specific example) but not more than 5km. The upper picture shows a spacing of 2000 meter, which would lead to the creation of 191 lines, which is too much. Therefore the spacing was increased to 3000 m between the lines, which would generate 103 samplers (lower picture), a much better approximation to the targeted number of 100 lines.

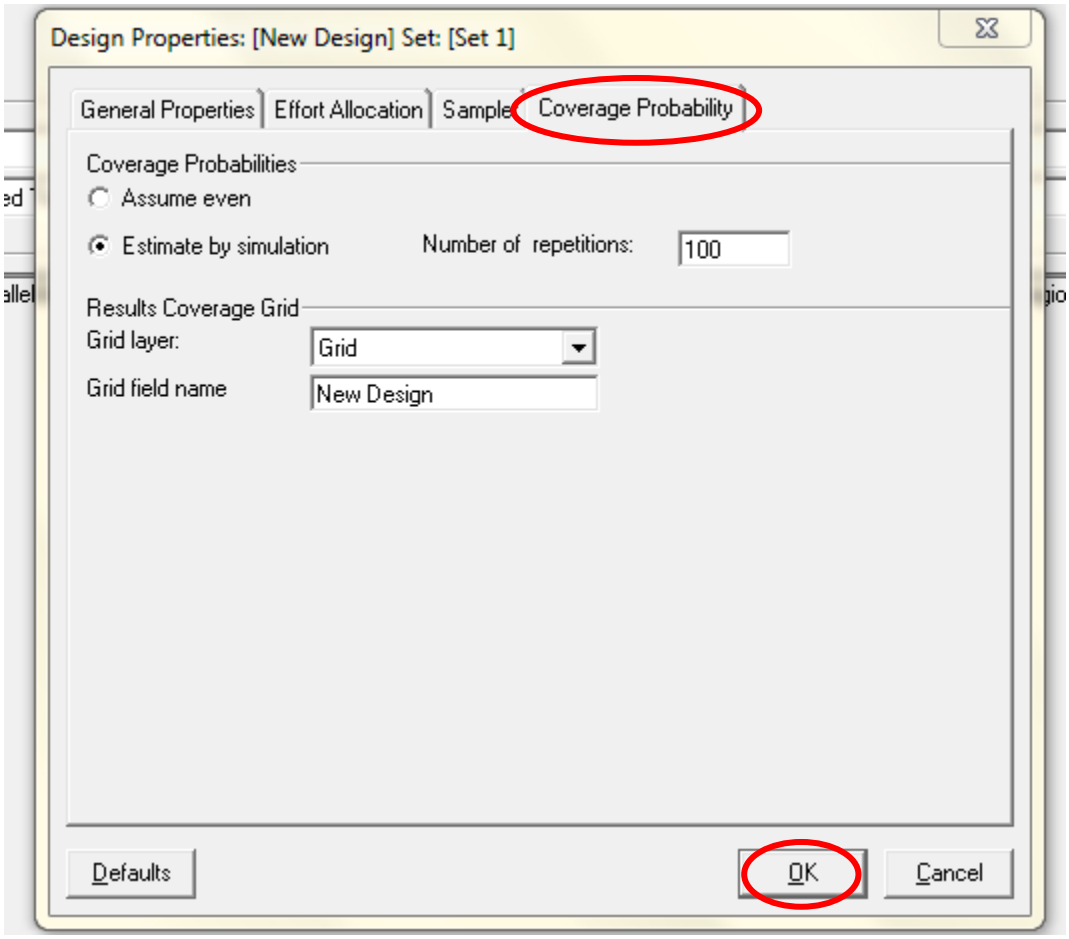




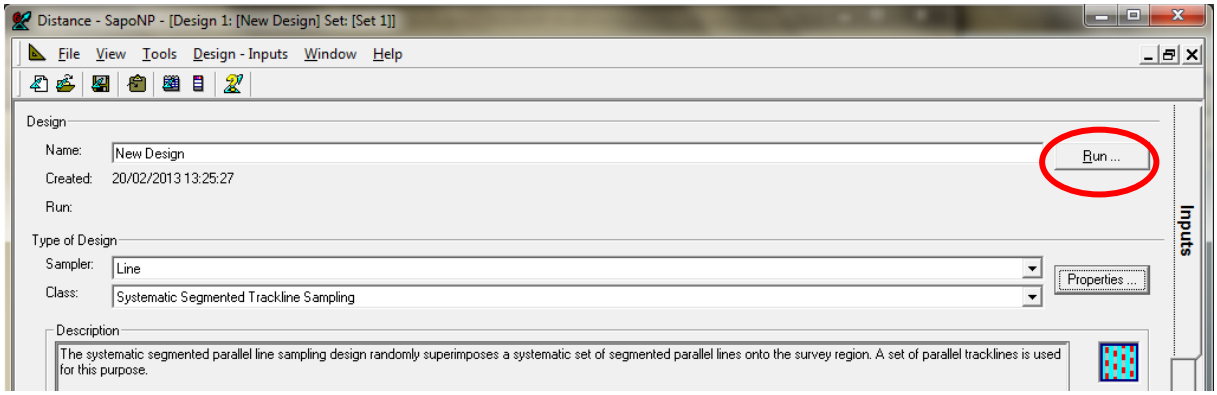
If you are satisfied with your settings in this Tab “Effort Allocation”, click on the “Sampler” Tab and set the “Line sampler width units” to “Meter”, and the Width at “1” (see picture below).



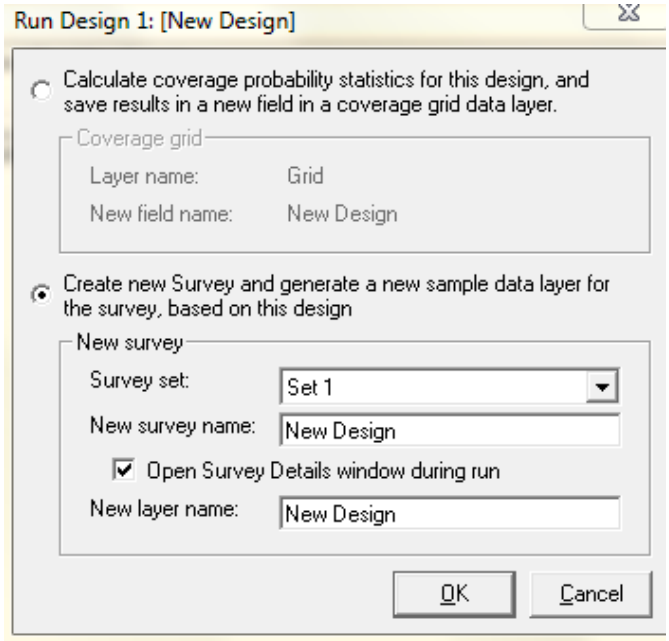
Finally you go to the Tab “Coverage Probability” and select “Estimate by simulation” with 100 “Numbers of repetitions”. Now you have set all parameters and click “OK”.



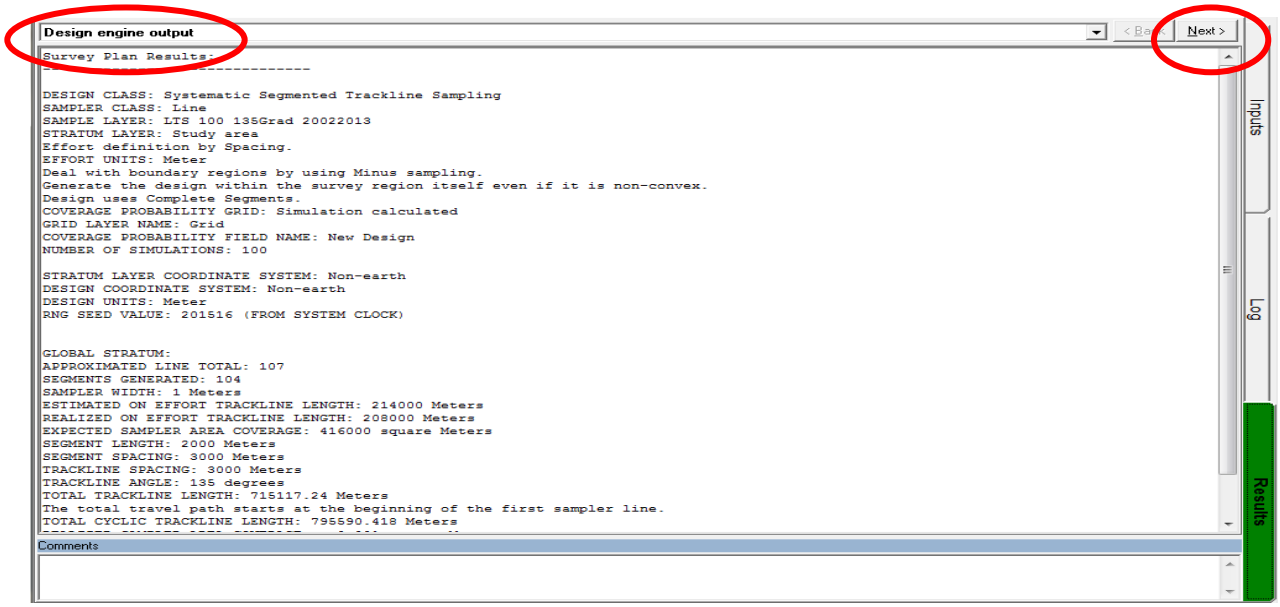
14. After you have clicked “OK”, the program returns to the Design window, which you have already seen in Step 12. Now click on the button “Run” on the right side (indicated by red circle in picture below).



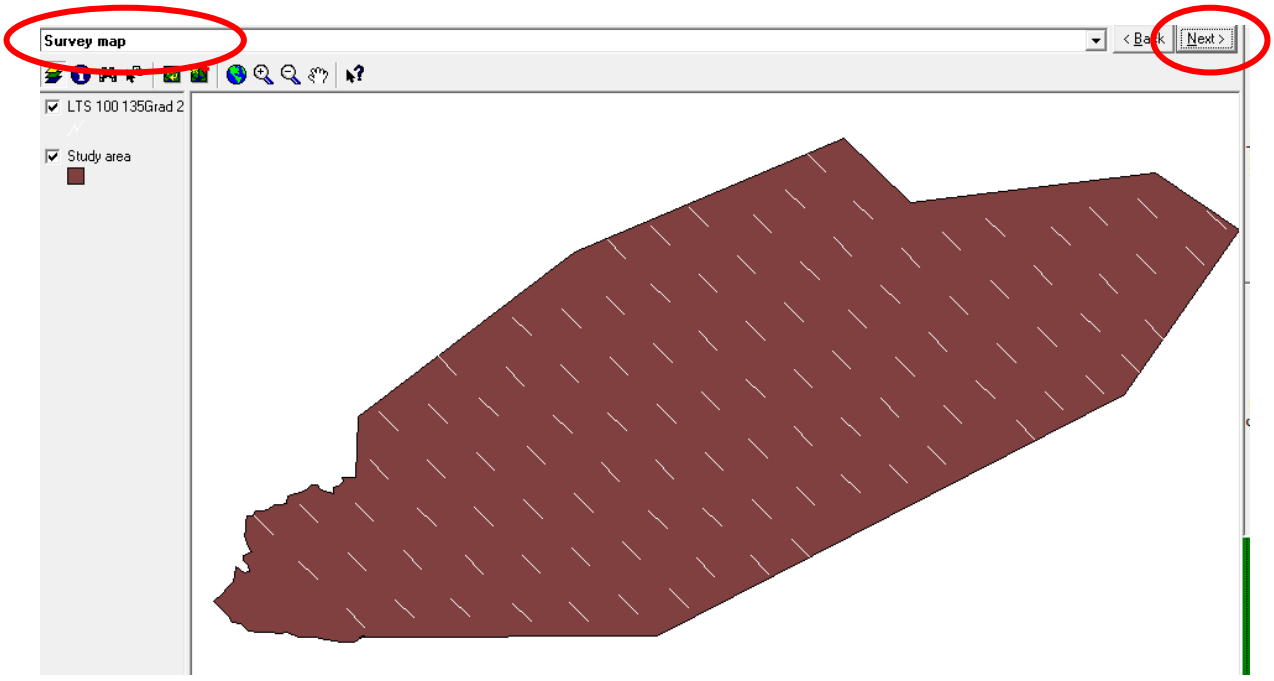
The following window will appear. Choose the second option “Create new Survey” and click “Ok”.

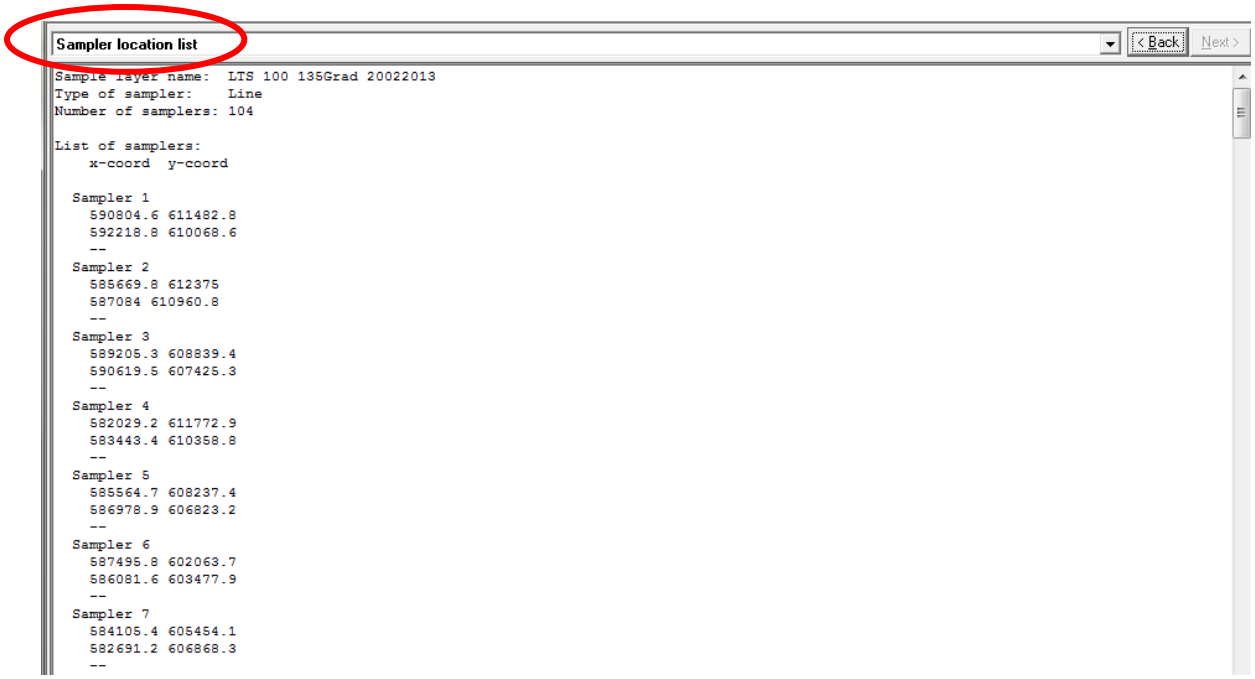


15. You automatically should get a “Design engine output” like this:

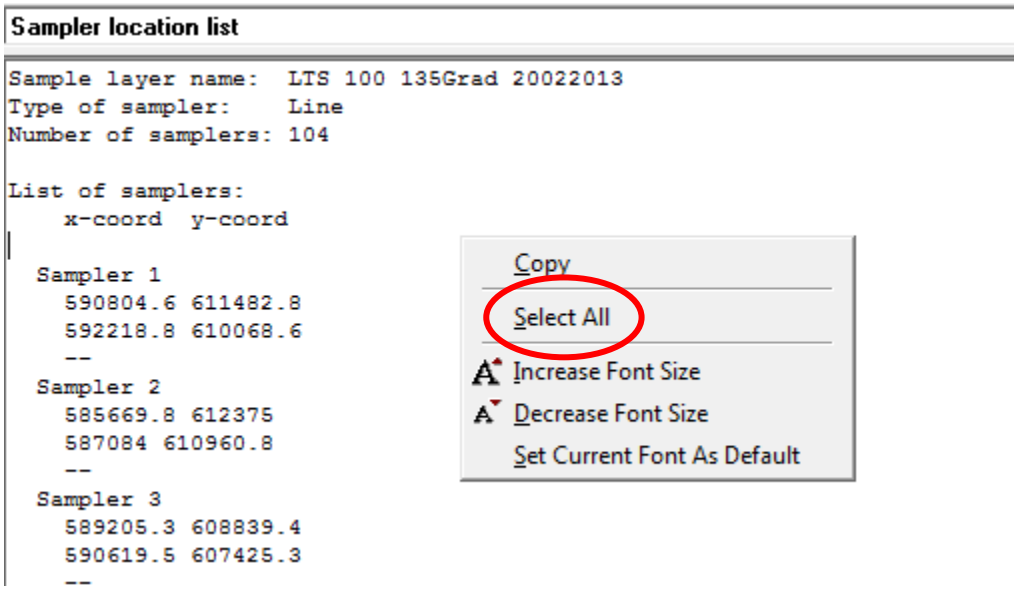


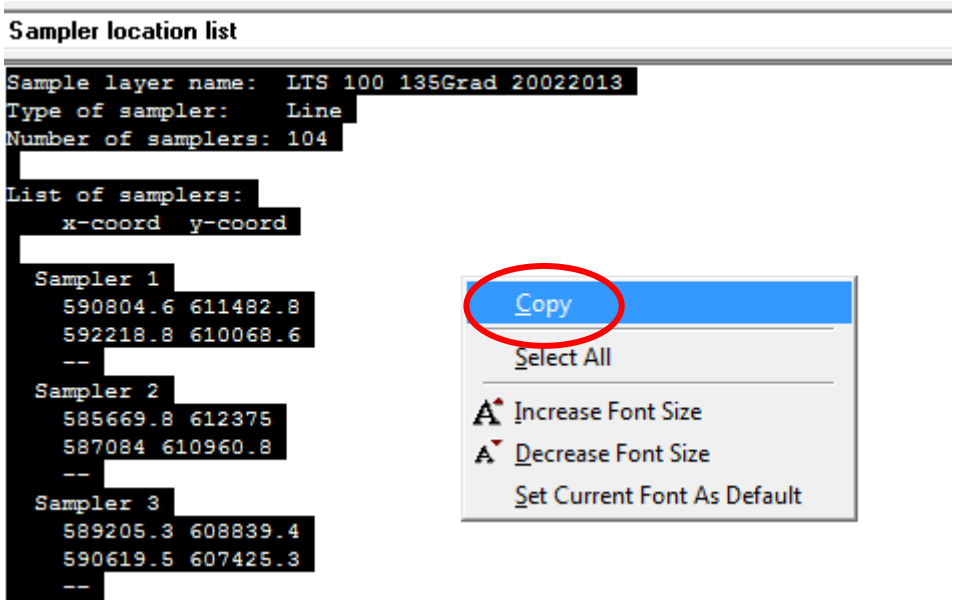
The first page contains general information about the survey design. If you click on the button “Next” in the upper right corner you will see the second page, the “Survey Map” (below), showing the layout of your transect lines. If you click “Next” again, you will come to third page “Sampler location list”, which contains the X- and Y-coordinates of your transect lines. They are called “Sampler” and are numbered. Each sampler has two pairs of XY-coordinates; the upper marks the starting point, the lower pair the ending point of your transect.





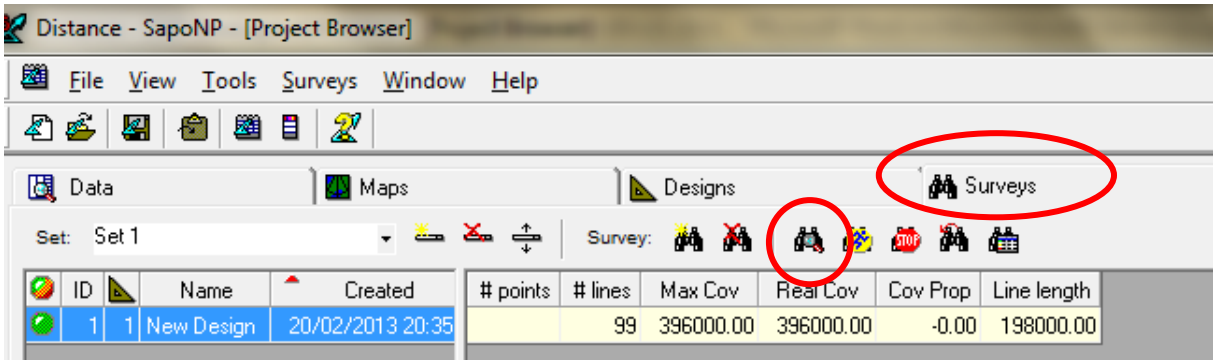
You have to select them all and copy them either into an Excel file or a Word file (click at any place into the list and then use the right mouse button – a small dialogue box will appear and you choose "Select All", see picture below. All data in the list will be highlighted and you again use the right mouse button, now select "Copy". Open a blank Excel or Word document and paste the data.). Before you switch back to DISTANCE, save the Excel or Word document, for example as "TransectLayoutSapoNP".xls.



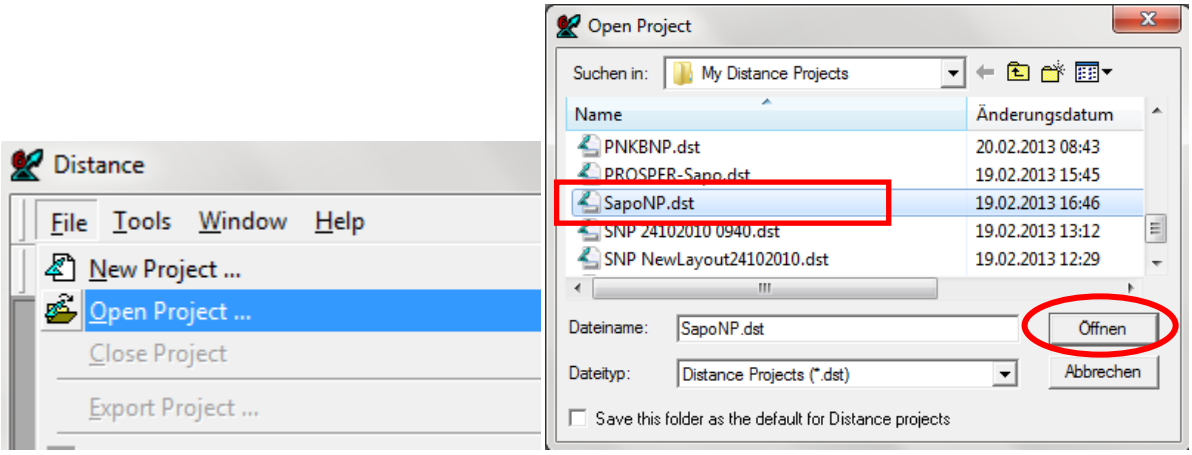


16. Back in DISTANCE close the Sampler location list by clicking on the **x** on the right.

17. Your design results will be automatically saved in the "Surveys" Tab, and you can view them by clicking the icon "Show details of selected survey" (see the left small red circle in the picture below).

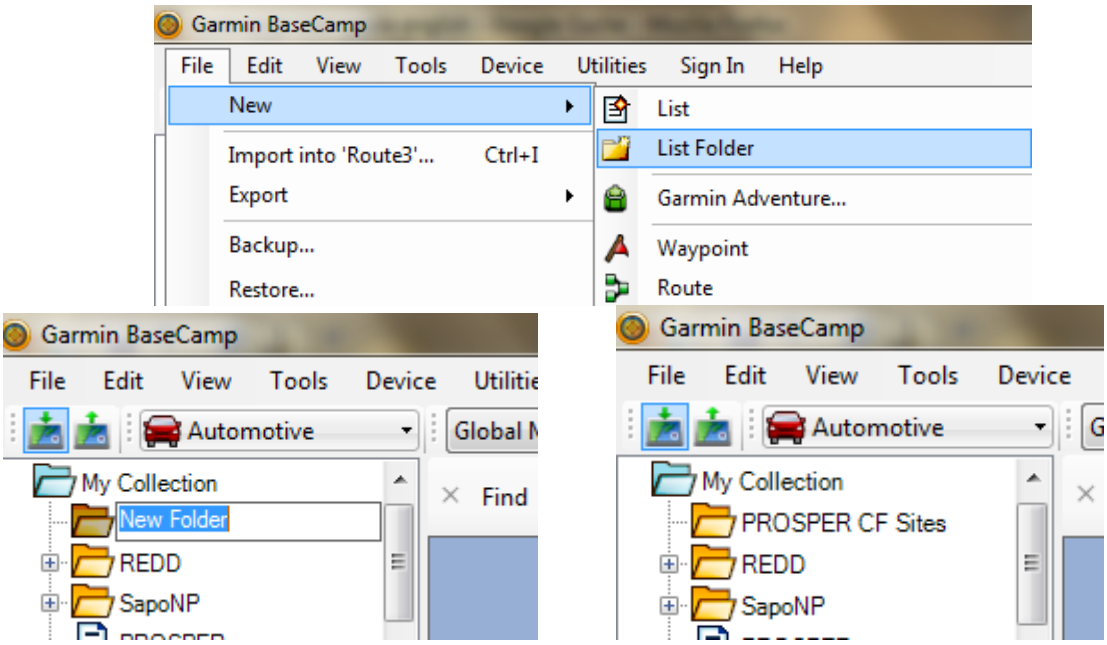


18. Now close DISTANCE by clicking on “File” and then “Exit”. All your features will be automatically saved. The program will ask you if you are sure you want to close, confirm with “Yes”. In case you want to open your file and see your data again, just start the DISTANCE program and click on “File”, and then choose “Open Project” (left picture below). A dialogue box will open (right picture below). Choose the project, i.e. the “**.dst**” file you have created in Step 3 (e.g. “SapoNP.dst”).

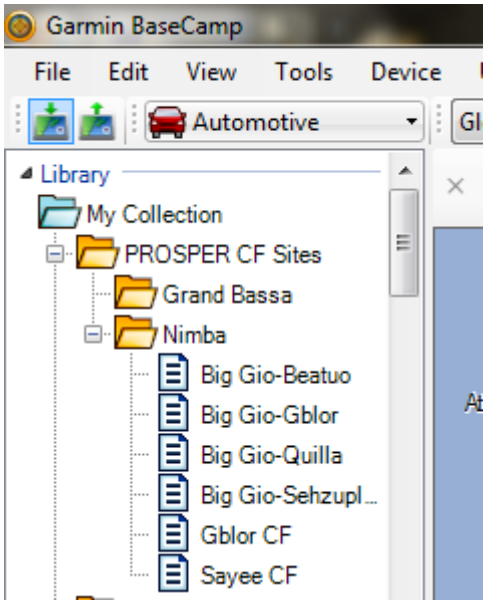


19. The last step in this section is now to transfer the coordinates to the GPS. This will be done by using the GARMIN BASECAMP program. You will first have to transfer the transect lines coordinates, which you have created with DISTANCE, to BASECAMP, where they can be easily transferred to the GPS.

20. Open GARMIN BASECAMP and click on “File” and choose “New” ► “List Folder”. This will create a new folder within the overall folder title “My Collection” (see lower left picture). It is advisable that you create a good data management system right from the beginning. Within each folder you can establish other folders and lists. You can give the New Folder a new name such as “PROSPER CF Sites (lower right picture).

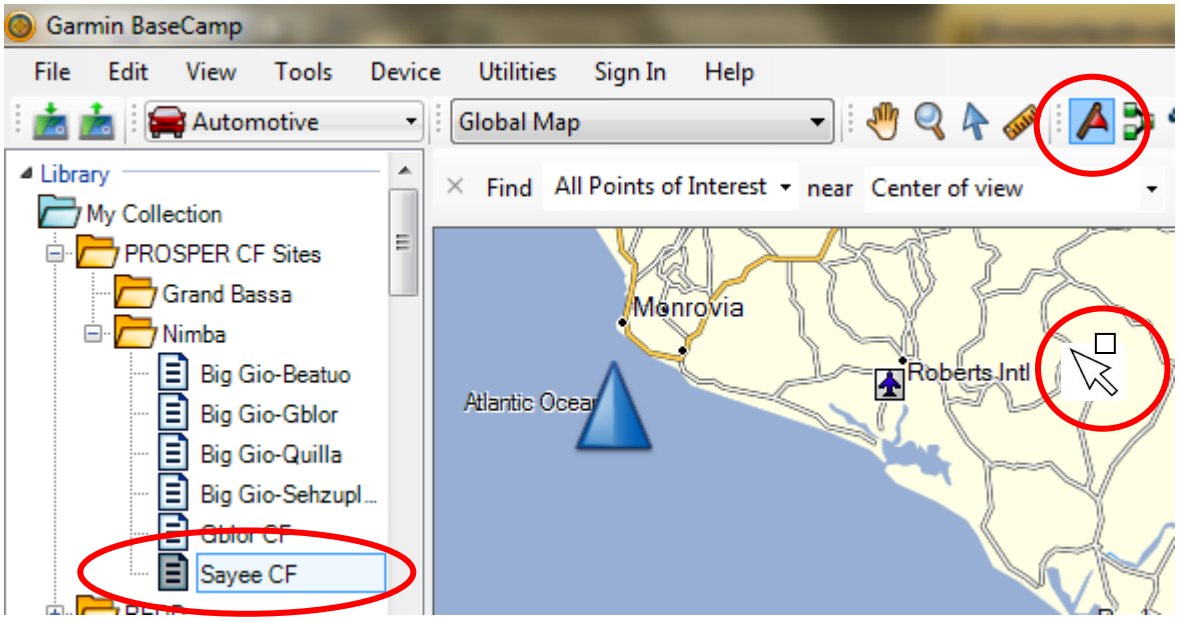


Within the “PROSPER CF Sites” folder you create one folder for each CF County (e.g. Nimba and Grand Bassa), and within the County folders you create a list for each CF site (see example below). You do this as explained above, by clicking on “File” and then “New” and then either “List Folder” or “List”.



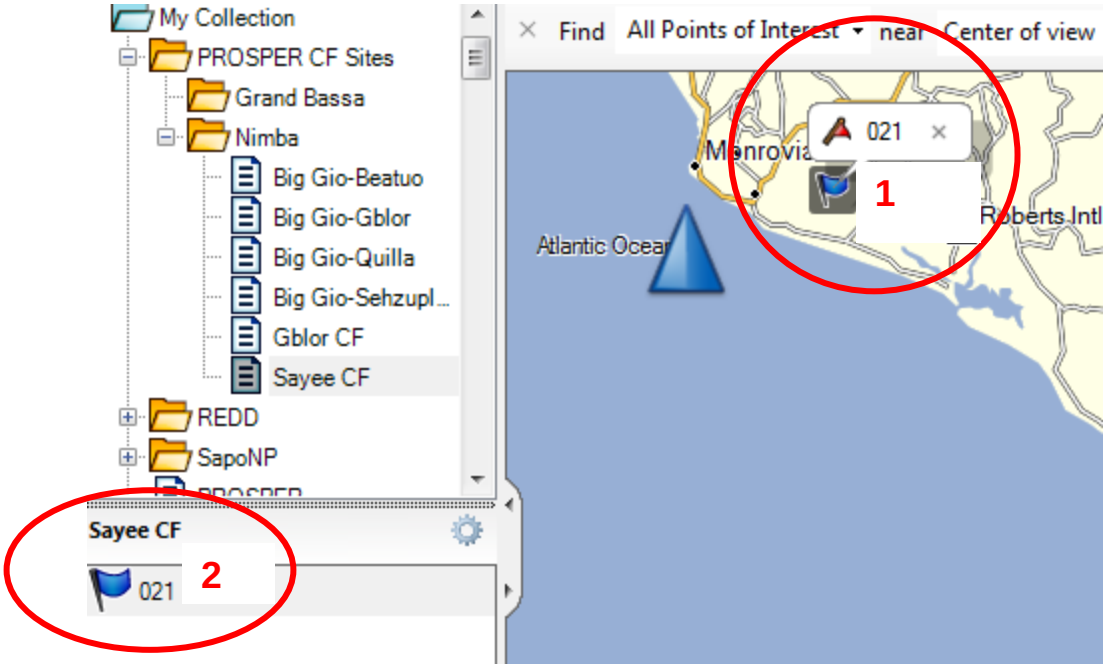
21. Next you will have to enter the transect line coordinates of the respective CF sites into the respective **lists**. Let’s assume you have created the transect coordinates for the Sayee CF as explained in Steps 1-15 above. You have saved these coordinates in a Word- or Excel document and now need to enter them into the list “Sayee CF” in BASECAMP. Single coordinates, i.e. one XY-pair, are also called waypoints. It means you have to create waypoints in BASECAMP. Each transect line is characterized by two waypoints – one XY-pair marking the starting point and one XY-pair marking the ending point. Open the file where you have saved the DISTANCE coordinates. You will have to enter the coordinates manually in BASECAMP (there would be a more sophisticated way of data transfer, which however would require ArcGIS).

22. In BASECAMP, highlight the list in which you want to enter the waypoints (in the example below Sayee CF), and then click on the icon “New Waypoint” (the red little flag).

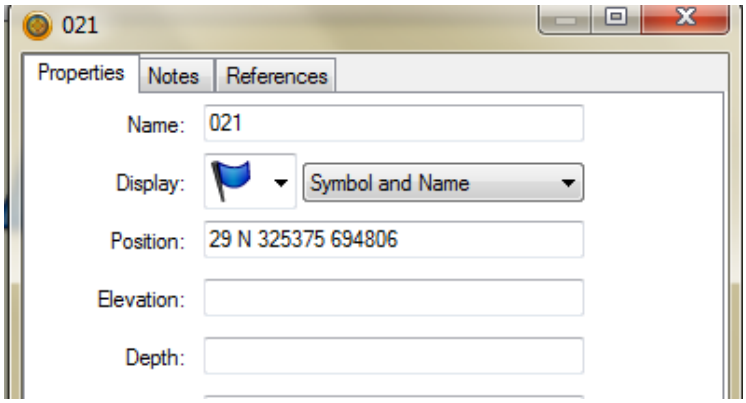


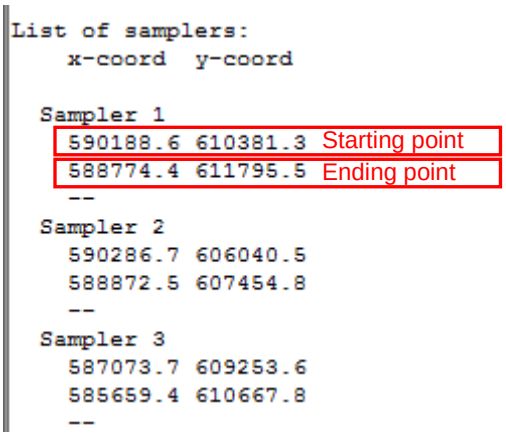
If you move the cursor you will see that now there is a little box attached to it. This symbols the waypoint you are going to place. Click anywhere in the map to set your waypoint

23. Two things will happen: (1) the waypoint will appear in the map and (2) also in the submenu of the “Sayee CF” list (see picture below). The symbol and number is given automatically by the program and might look different in your case, depending on the default settings.

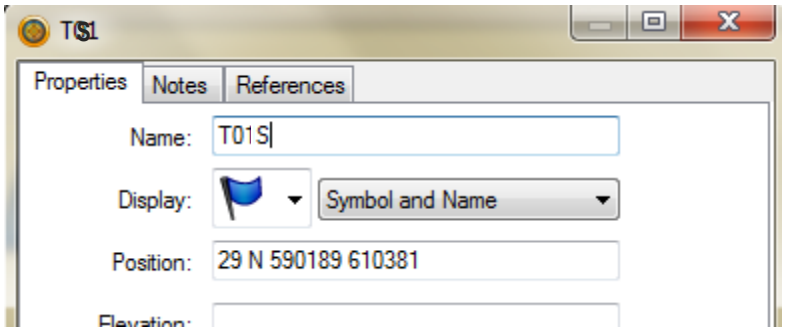


24. Now double-click on the waypoint in the submenu. A dialogue box will open showing the details of the waypoint (left picture below), and allows you to make changes. First of all change the name of the waypoint. It should be short, convenient and explicit. If, for example, you have 10 transect lines in one CF site, they should be named T01, T02, T03 etc. The starting points of the transects should then be T01S, T02S etc., and the ending points T01E, T02E etc. DISTANCE created two XY-pairs for each transect line (which in DISTANCE was called "Sampler"). The upper pair is considered as starting point and the lower pair the ending point (right picture below).

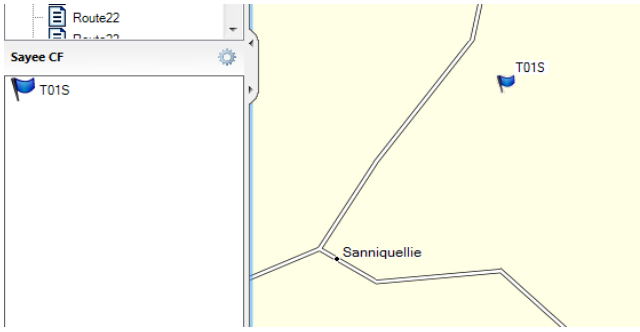




25. Give the waypoint the name T01S and change the coordinates in the "Position" field. For T01S use the upper XY-pair of Sampler 1 that was created by DISTANCE. 29N stands for Liberia and shall not be changed, only the X- and Y-coordinates right to it. Note that in BASECAMP coordinates are expressed as integer numbers (i.e. 6 numbers per coordinate) and **not allowed** to carry decimal points or fractions. The coordinates created by DISTANCE however show one decimal point and therefore need to be rounded up or down to integer numbers. In our example the coordinates of the T01S waypoint are 29N 590189 610381 (see picture below; compare also with the coordinates of Sampler 1 in the right picture above). After you have changed the name and position, close the dialogue box by clicking on the X on the right upper corner. (If you like you could, before closing, also change the symbol by clicking on the small arrow ▼right to the flag symbol and choose whatever other symbol you prefer).



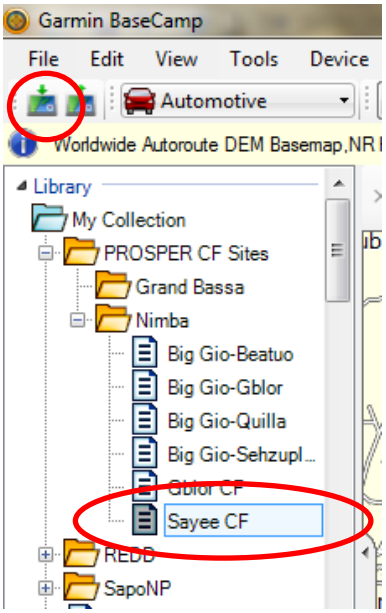
26. You will see the changes both on the map (not only has the name changed but also the position) and in the submenu.

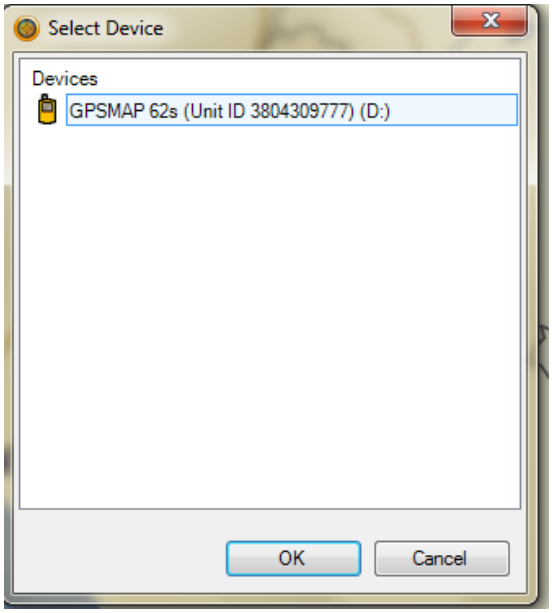


27. Repeat steps 22-26 until you have created all your transect starting and ending points for the respective CF site.

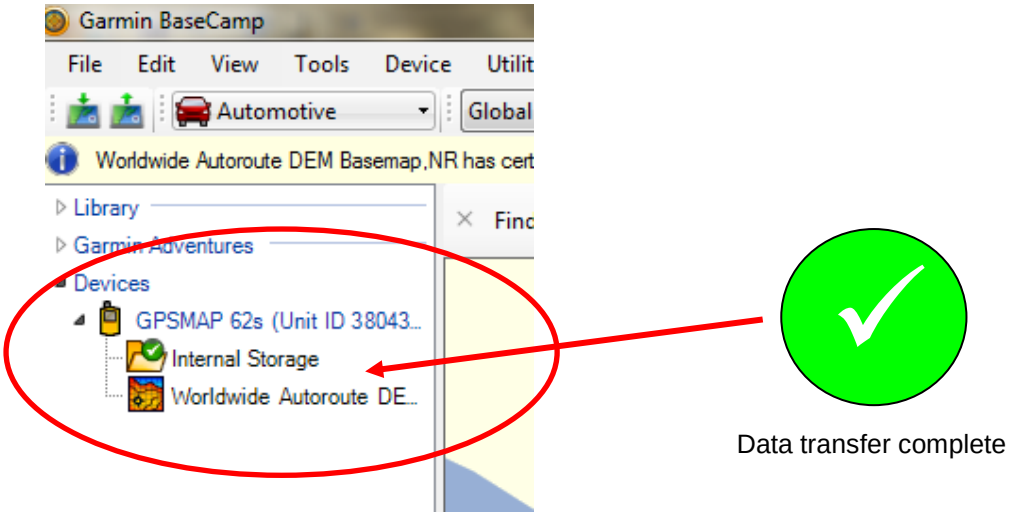
28. Connect the GPS with the computer (the USB cable comes with the Garmin device).

29. Highlight the list or folder which contains the GPS data you want to transfer to the GPS. In our example below, we want to transfer the Sayee CF list to the GPS. Next click on the left symbol below "File" which is marked by the small red circle in the left picture below. As soon as you move the mouse cursor close to it, it will say "Send 'Sayee CF' to Device…". Make sure that the correct list or folder will be sent. If you click on the symbol a window will appear (right picture below), asking you for selecting the GPS device, to which you want the coordinates be sent to. Usually you will only have one GPS at the same time connected to your computer, so there should be only one unit displayed (in the example below it is a Garmin GPS Map 62s with a certain ID number). Highlight the GPS device (click on it with the cursor) and then click on "OK".





30. Each time you connect a GPS to the computer, it will be displayed in the left menu bar in BASECAMP (below the "Library", which contains all your data; see left picture below. In that picture the Library has been closed for the reason of clarity, so that the subfolders and lists are not visible). As soon as you start a data transfer you will see a green bar below in the GPS folder. As soon as data transfer is completed, a green checker symbol appears. You can now close BASECAMP and remove the GPS from the computer.



3.2 STEP 2: ESTABLISH TRANSECT LINES IN THE FIELD

Note: *Before carrying out Steps 2-4, train field staff on Module 1 (see Chapter 5)*

Depending on the number of transects, size of CF site and accessibility etc., it is recommended to plan several multi-day field trips to set up the transect system. It should be done together with the Field Assistant and Field Teams, and initially supervised by the Program Coordinator. A list of the required equipment is attached in Annex 1. The starting and ending points of the lines must be saved in all GPS units which will be used for the work (see steps No. 28-30 in section 3.1 above). The establishment of a transect line comprises two major parts: (i) the cutting of a straight line, and (ii) the marking and habitat description, and will require four to five people: 1 compass person, directing the cutters; 2 cutters; 2 persons for measuring, marking and data recording. Since – depending on the vegetation – the cutting most probably will take the most time and cause the other people to wait, the measuring, marking and data recording could also be done by one person only. In that case the compass person would carry the leading end of the measure tape along with him, while the data recorder would carry the other end and observe the correct measurement of sections (which will be 50 meters, see below). It should be possible to complete one line (à 2 km) within 1.5 – maximum 2 days. The main workflow is described below.

1. Navigate to the starting point of the transect. In case the ending point should be closer to your base camp, you can also start cutting the transect from the ending point, **but it is essential that you consider the cutting direction**. If you begin at the ending point, the line will run in the opposite direction of your predetermined compass bearing, which means you have to add or subtract 180° to/from it. For example, if your transect lines should run from West to East, it corresponds to a compass bearing of 90° if you start at the starting point. If you start from the end, the cutting direction logically must be from East to West which corresponds to a compass bearing of 270°.

2. As soon as you reach the starting point, look for a suitable tree in close vicinity, which will mark the beginning of the transect. Delete the original waypoint in the GPS and safe the actual starting point. Give it the same name as the original one (for example T01S).

3. Cut a stake for placing the compass. It should be thick enough to hold the compass, and its surface must be flat and even to ensure that the compass is leveled (see Figure 1). The compass person should set the compass to the determined bearing, place it on the stake and orientate it towards the correct direction.

4. Cut a second stake, which will be used by the first cutter to mark the transect line. The first cutter should go ahead in the approximate compass direction **without cutting** anything yet. He should go as far as possible, but must still be clearly visible for the compass person. The compass person then will direct him to stand exactly in the centre of the transect line and to plant the stake. Now both cutters start to clear the vegetation along the line. The second cutter will start from the position of the compass person, heading towards the first cutter, who on his part will cut towards the second cutter. Both have to be carefully supervised by the compass person, who immediately has to call out a correction in case one of them deviates off the path. *A well cut, straight transect line is essential for good data collection.* The compass bearer further has to monitor the extent of clearing. A balance has to be found between the minimum damage to vegetation, and an adequate width and accessibility to allow unimpeded movement and data collection.

5. As soon as the respective section has been cleared, the compass person and the two cutters move forward towards the marking stake and repeat the same procedure.

6. The data recorders wait at the starting point, and mark the tree and fill the habitat description sheet (see section 3.3 below). This will be done every 50 meters along the transect line. Trees will be marked with colour paint (red or white, it should be a colour that is clearly visible in the forest, so preferably not green or yellow). The starting and ending points will be denoted by the transect number and the meters, e.g. the starting point of Transect No. 1 by "T01 0", and the ending point by "T01 2000". The 50 m marks along the transect will be tagged by the respective meters only (50, 100, 150, 200, etc., e.g. Figure 2). The marking should be done at eye-level and must be clearly legibly, also from a distance, so letters and numbers should not be too small. If necessary, clear the stem from lianas, moss or lichens, but don't scrape off too much of the bark and avoid any injuries of the tree itself. As soon as marking and data recording have been completed, one person will follow the cutting team, carrying along the leading end of the tape measure and the colour. The second person will stay behind, holding the other end of the tape measure, stop the first person when reaching 50 meters, and then follow.

7. The first person will temporarily mark the 50 meter mark (with a stick or by scratching the soil with his foot), and look for a suitable tree close to the transect line and the 50 m mark, respectively. If no large-stemmed tree is found, numbers can also be written vertically instead of horizontally on small stems (see Figure 2). The number should face the transect line.

8. As soon as the data recorder reaches the 50 m mark, he will fill the habitat description sheet.

9. The whole team moves as described until reaching the ending point at 2000m. It will be tagged by "T01 2000" (for Transect 01), and the last record in the habitat description sheet take. Further, delete the original GPS point in the GPS (T01E) and mark the "real" ending point, by giving it the same name (T01E). The set-up of the respective transect line therewith is completed.

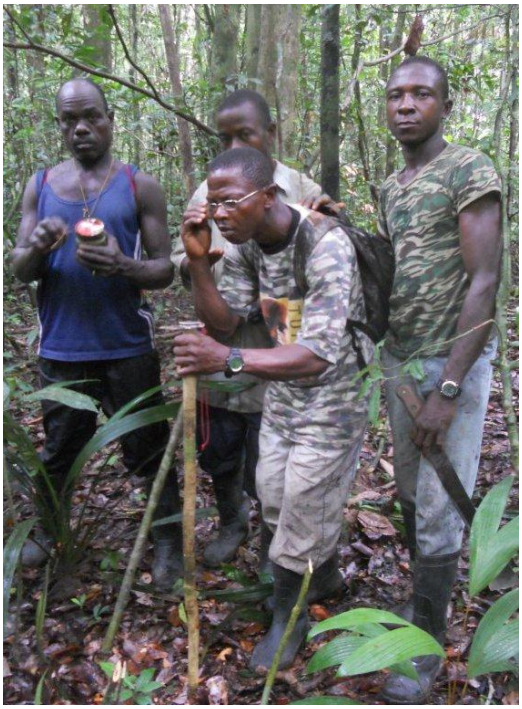


Fig. 1. Compass reading

Fig. 2. Marking of small-sized trees

3.2.1 HOW TO NAVIGATE AROUND AN OBSTACLE?

It might happen that the transect line is blocked by an obstacle such as a big tree, a fallen tree or a rock. In such a case, the following procedure should be applied. First of all, if it is possible to pass or overcome the obstacle without risk, the transect line should be just continued, and hence will include the obstacle. This means for example that one can climb over the fallen tree or the rock without taking a detour (Figure 3). In case the obstacle is insurmountable, or a big tree is standing exactly on the transect line (Figure 4), the blockage needs to be surrounded, which means that you will have to leave the transect line and thus deviate from the correct direction. How can you find the line and correct the bearing again after surrounding? Do the following (see Figure 5 below): First you have to decide whether you will turn right or left in order to surround the obstacle. As a general rule, in case you turn right you always have to add, and in case you turn left you have to subtract 90° to/from the compass bearing. In the example below, the transect line direction is 180°, and the obstacle, a fallen tree, is surrounded on its right side. Follow the steps as described in Figure 5. *It is crucial to carry out the procedure as explained by using the compass and exact measurements, and not just follow one's own approximate estimates*.

Fig. 3. The transect line is crossing a buttress root.

Fig. 4. The transect line (indicated by the red arrow) hits a tree.

Since the part of the transect line which is blocked by the obstacle can also not be surveyed later on during the annual monitoring, it will not be included in the total length of the line. It means that the transect line length is interrupted by the obstacle, and hence the length measurement has to be continued behind the obstacle. If, for example, an obstacle is encountered at 480 meters, surround the obstacle and, when back on the line, continue the length measurement originating from 480 meters (Figure 6). In practice it means that, before leaving the transect line, take the measurement up to the point where the transect line hits the blockage.

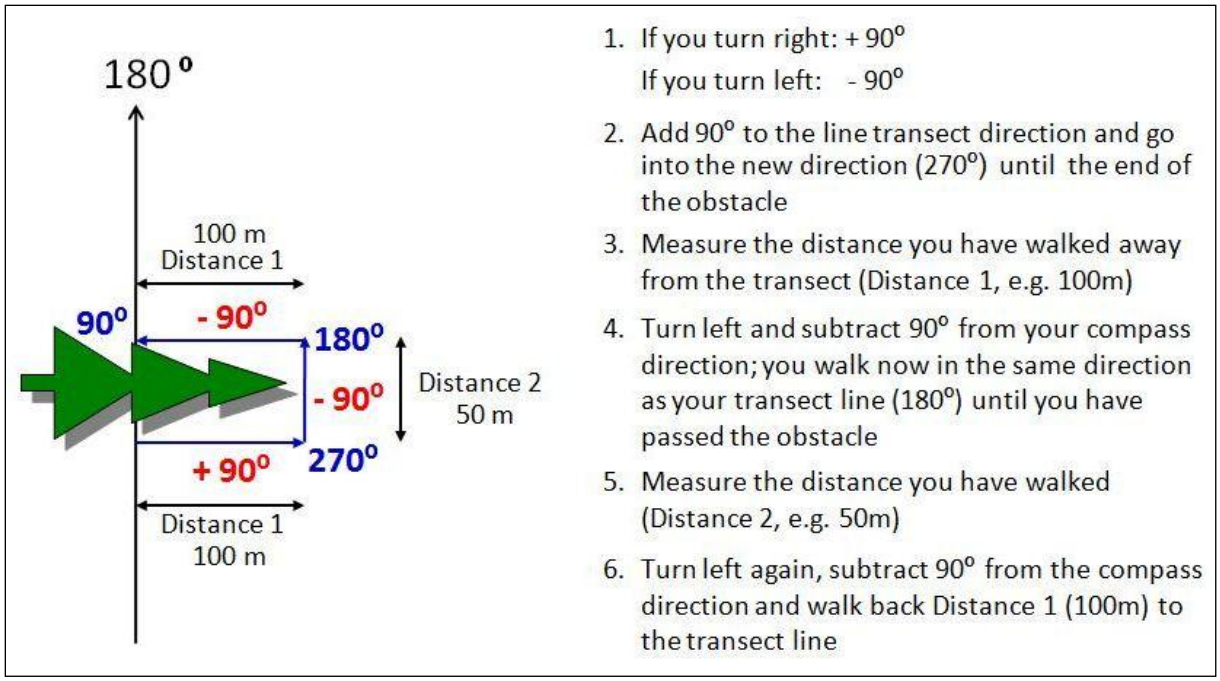


Fig. 5. How to surround an obstacle.

The same applies if the transect line is crossing a creek or river. The width of the watercourse will not be included in the total transect length (Figure 6).

Fig. 6. Example where the transect line (red arrows) hits a creek. The creek's width is not included in the total transect length.

3.3 STEP 3: HABITAT DESCRIPTION OF TRANSECT LINES

A habitat description sheet will be filled at the starting point, every 50m and at the ending point of each transect. The full form is attached in Annex 2A, while Figure 7 below just shows a cut-out for easier description in this section.

Habitat Description - Transect No.:

Transect No.: **Date:** **Team:** **Cutting direction:**

	Forest Structure						Topography		Water resources	Notes
Meter	Type	Tree species	Tree height	Lianas	Canopy cover %	Ground cover %	Level	Elev.		
0										GPS Data
50										
100										
150										
200										
250										
300										
350										
400										
450										

Forest Type: **PF** Primary Forest/Old Secondary; **YS** Young Secondary; **FB** Farmbush; **TH** Thatch
Tree Species: **Mix** Mixed; **Dom** Dominant (mention dominant tree species in the "**Notes**" column)
Tree height: **20; 25; 30; 35; 40 etc.** (estimate the average height (m) of the highest trees)
Lianas: **0** none; **1** few; **2** medium; **3** many
Canopy Cover %: **0; 25; 50; 75; 100** (as perecentage of the sky that is covered by canopy)
Ground cover%: **0; 25; 50; 75; 100** (as percentage of ground that is covered by ground vegetation)
Level: **LL** Lowland; **S** Slope (↑ uphill; ↓ downhill); **R** Ridge
Elevation: in meters, read from GPS
Water: describe if swamp or creeks etc. nearby transect
Notes: describe special features, e.g. treefalls, camps etc.

Fig. 7. Example section of the habitat description sheet.

3.3.1 EXPLANATION

Headlines

Transect-No.:

The "ID-Number" of transect (e.g. T01)

Date:

Self-explanatory

Team:

Self-explanatory

Cutting direction:

Enter point and compass bearing (e.g. T01S, 90°, if you start cutting Transect No. 1 from the starting point and from West to East; or T01E, 270° if you start at the ending point and your cutting direction is then vice-versa, running from East to West which corresponds to 270°)

Forest Structure

Type (= Forest Type):

Primary Forest refers to untouched, pristine forest that exists in its original condition. This forest has been relatively unaffected by human activities or other disturbance. Primary forest is characterized by large, old trees, a full ceiling canopy and usually several layers of understorey. The ground floor is generally clear of heavy vegetation because the full canopy allows very little light, necessary for plant growth, to penetrate. Occasionally, when a canopy tree falls, a temporary light gap is opened in the canopy, allowing growth of floor and understorey species.

Secondary Forest is a forest that has been disturbed in a wide scale, either naturally (by fires, floods, land-slides, wind throw etc.) or by humans (logging, clear cutting, slash-and-burn etc.), and then left to regenerate. Depending on the level of degradation, secondary forest generally is characterized by a less developed canopy structure, young and smaller trees, less diversity, and, as more light reaches the floor, a dense ground vegetation. As times passes since the initial disturbance, both the species composition and the structure of the forest will change gradually. This gradual change is known as "forest succession". Initially the land will be covered by weedy shade-intolerant plants and shrubs that thrive in open light conditions and grow and reproduce quickly. Within a year, a few, thin trees will appear above the dense ground vegetation. With time a taller, more closed-canopy forest, characterized by many small and medium-sized trees will be observed, and the ground vegetation will become less dense. This forest can be described as *Young Secondary Forest*. With the passage of time, the forest will further change in terms of structure and species composition and gradually will turn into an *Old Secondary Forest*. If it will remain undisturbed and experience little change in species composition and structure over a long time, it may again become again a Primary Forest.

It is sometimes difficult to distinguish between Primary and Old Secondary Forest, because we do not know, how old a forest is and how long it has been undisturbed. In general the forests of West and Central Africa mostly are very Old Secondary Forests. So for the habitat description we will only distinguish between **PF** (Primary/Old Secondary Forest) and **YS** (Young Secondary).

Farmbush is an open, regenerating area which has recently been used by humans for plantation etc. It is not a forest yet, i.e. usually lacks of trees, but mainly contains weedy plants, creepers and shrubs.

Thatch is an area (usually in the forest) which is covered heavily by thatch plants. In the habitat description we will add this information to the forest type (e.g. **PF** + **TH**).

Note: Local people often use the term "Low Bush", which refers either to (very) Young Secondary, Farmbush or the (naturally low-growing) vegetation that can be found close to rivers. This term should be avoided in the habitat description sheet, as it is not specific. Only use the terms explained above.

Tree species:

It is not necessary to identify the various tree species around the 50m mark, but it should be mentioned whether there is a mixture of different species or if one species is dominant. For example in a swampy area, *Raphia* palms might dominate the overall tree species composition. Use the abbreviation **MIX** for a mixture composition and **DOM** for dominant. In the latter case, also specify the dominating tree species in the "**Notes**" column (last column of sheet).

Tree height:

Estimate the average height of the higher trees around the 50m mark. Use 5 meter intervals.

Lianas:

Lianas are long-stemmed, woody creepers that are rooted in the soil at ground level, but cannot support themselves and therefore use trees as well as other means of support to climb up to the canopy in order to get access to sunlight. They are characteristic of tropical rainforests and often dominate the middle-storey, forming bridges between the trees and canopy, providing animals with paths across the forest. The amount of lianas present in the area surrounding the 50m mark will be described with numbers from 0 – 3 (0 = none, 1 = few, 2 = medium and 3 = many).

Canopy Cover:

If you look up to the sky, how much of the sky is covered by the canopy? This will be expressed as percentage, by using 25% intervals:

- 0–25% means that the canopy is very open, i.e. less than a quarter of the sky is covered
- 25–50% between a quarter and half of the sky is covered
- 50–75% between half and three quarters of the sky is covered
- 75–100% means that the canopy is very closed, you cannot see much of the sky

Ground Cover:

How much of the forest floor is covered by the ground vegetation? Again use percentage and 25% intervals:

- 0–25% easy to walk, i.e. less than a quarter of the floor is covered
- 25–50% between a quarter and half of the floor is covered
- 50–75% between half and three quarters of the floor is covered
- 75–100% floor densely covered

Topography

Level:

We distinguish between lowland (plain, flat area), slope (going up or down a hill) and ridge (top of a slope, hill). Use the abbreviations as explained in the form's key (LL for lowland etc.).

Elevation:

The elevation is the height above sea level (it means how high your area is compared to sea level, which is defined as 0 meter). You can read the elevation from the GPS. It should be expressed in meters.

Water resources

Describe if there are any water resources (stream, creek, swamp, pond etc.) nearby the transect, or if the area is (seasonally) flooded.

Notes

Here you fill in if there are any special features along the transect, for example a big gap in the canopy due to a fallen tree, hunter or miner camps etc. These features will not always be located exactly at the 50m-marks, but nevertheless they should be recorded. If you encounter anything

interesting between two 50m marks, just record it in the notes column of the nearest 50m mark (If, for example, the transect line passes a huge treefall at 90 meter, take a note on that in the 100m row of the notes column). Secondly, the notes column should be used to specify the dominant tree species, in case the "Tree species" column was filled in by **DOM**, and to note the GPS coordinates of the starting and ending point (it is not necessary to save all 50m mark coordinates, only the starting and ending).

3.4 STEP 4: SET-UP AND OPERATION OF WEATHER STATION

Weather data will be recorded in two ways. On the one hand, notes will be taken during the biomonitoring data collection along the transects during the annual surveys (see section 3.5). They will reflect particularly the conditions during the monitoring period on the respective survey days, and serve as ancillary information on general observation conditions. More details on that will be given in section 3.5. On the other hand, it is recommended to set up a fixed weather station at a central place of each CF site (for example in the community's seat town) for permanent data recording throughout the year. There are different types of weather data, such as temperature, rainfall and humidity, wind direction and speed, cloud cover and solar radiation. The first three are the most common ones and are relatively easy to monitor, and thus will be the focus of the CF site's weather recording, whereas the other parameters require more complex tools and will not be included.

3.4.1 SET-UP OF WEATHER STATION

The following materials are needed:

- A weather box. The weather box will house the recording instruments. It is made of wood which should be painted white, and can be easily made by a local carpenter. Figure 8 shows an example of the general design. The internal dimensions of the box should be approximately 60x60x60 cm, it should have an inclined roof and will need some space between the walls and the roof for ventilation. The door should have a padlock to lock the equipment up. Since the temperature is by standard measured at a height of 1.25 – 1.50 meters above the ground, the bottom of the box has to be set at this height. It will therefore need 4 legs for supporting, which should have a length of at least 2 meters, so that they can be dug and anchored appropriately in the ground. The box should be set-up in an open area at least 30 meters away from buildings and tall trees.

- A digital thermo-hygrometer with maximum and minimum function, which will be placed inside the weather box (see Figure 8)

- A rain gauge. With regard to the tropical humid climate, and the high amounts of rainfall in the rainy season, its volumetric capacity should allow to catch comparatively large quantities. The rain gauge used in Sapo National Park, for example, is made up by 2 pieces (Figure 9): the main gauge which comprises up to 50 millimeters (Figure 9 left), and which is placed inside a protection container (Figure 9 middle), which has a funnel-shaped top with a small hole. The protection container does not only prevent excessive evaporation of the accumulated rain water, but also catches overflow during heavy rainfall beyond 50 millimeters. The rain gauge can, but must not be installed on the roof of the weather (in Sapo NP this was mainly done because of safety reasons, see Figure 8 and Figure 9 right). It could also be set up separately, for example fixed to a stick in the ground. By standard, it has to be mounted in an open area, at least at 30 cm height, and at least 30 meters away from buildings and tall trees.

Fig. 8. Exemplified design of a weather box. The thermo-hygrometer is placed inside, the rain gauge on top of the roof.

Fig. 9. Rain gauge and protection container, installed on the top of the box roof.

3.4.2 RECORDING OF WEATHER DATA

Weather data recording should be done by community members. It is recommended to train several persons who could take it in turns. The following data are recorded every day, always at the same time, usually at 9 am, and filled in a prepared monthly data sheet (Annex 2B), which should be provided by the Program Coordinator / Field Assistants.

Temperature is measured in degree Celsius (ºC) and we record the daily maximum and minimum. After recording, the thermometer has to be reset in order to start a new maximum-minimum recording period. Usually, an instrument with maximum-minimum function will always save the highest and lowest temperature until it is reset. Reset means that you erase the memory (and that's why it is also important to do it after recording). In case you forget to reset, there is the risk that you record the same values again on the next day. For example, assume that on the 10th of March at 9 am, the temperature display shows a maximum of 35.6 degrees and a minimum 24.3 degrees, respectively. These values refer to the preceding 24 hours (given that you did reset the instrument on the previous day after recording). Let's further assume that during the next 24 hours (until the 11th of March at 9 am) the maximum temperature will be 34.8 degrees and the minimum 24.8 degrees. If you forget to reset the thermometer after the recording on the 10th of March, the thermometer will keep the memory of the highest and lowest temperatures since the last reset (09th of March), which will still be 35.6 and 24.3 degrees, respectively. So on the next day (11th of March) you erroneously will record the same data as on the 10th of March.

Humidity is measured in percentage (%) and we record the daily maximum and minimum. After recording, the hygrometer has to be reset in order to start a new maximum-minimum recording period (as explained above).

Rainfall is measured in millimeter (mm) and we record the daily total amount. In case there is overflow in the protection container, note the amount in the main gauge first on a piece of scrap paper, then empty the main gauge, and use the main gauge now to measure the amount that has accumulated in the protection container. Add all values and enter the total in the recording sheet. Make sure that, after recording, both the main gauge and the protection container are completely empty. Especially in the rainy season, in order to prevent overflow of both containers and hence loss of rainwater due to multiple heavy rainfall, it is recommended to measure the respective amounts immediately after the rainstorm rather than waiting until the next morning at 9 am. Do as described above – measure and note all amounts on a piece of scrap paper, empty the gauge and container, and add all values at the next recording time.

How to analyze the weather data will be explained in section 3.7.

3.5 STEP 5: DATA COLLECTION PROTOCOL

Note: *Before carrying out Step 5, train field staff on Module 2 (see Chapter 5)*

Once the transect system is established and the field teams have been trained on Module 2, the first monitoring cycle can start. In this section the basic data collection protocol will be presented, which is flexible and open for expansion depending on site-specific needs. Some examples for additional data collection are presented in Chapter 4.

As outlined in section 2.1 the basic protocol will focus among others on a subset of faunal indicator species. A proposed list is attached in Annex 3. It comprises 39 species (29 mammals, 8 birds and 2 reptiles), of which 11 by IUCN are classified as threatened (4 Endangered and 7 Vulnerable), and 9 as Near Threatened.

It is recommended that the Program Coordinator takes part in the first data collection phase, to ensure correct data recording and clarify upcoming questions directly in the field. The Field Assistants will not

only join the initial surveys, but might also have to take part in subsequent monitoring cycles, depending on the Field Team's capacity. *Correct and thorough data collection is essential*.

The following general guidelines should be considered:

- Each transect line will be monitored one time during a day survey. It should be possible to complete one transect in one day or less.
- Choose the transect line that you want to survey at least one day in advance.
- Four persons per team will carry out the data collection, while 2 stay in the camp for cooking and security. Two of the data collectors should focus on signs on the ground, such as tracks and dung, while the other two should observe the canopy, looking for birds, monkeys, and in particular for chimpanzee nests. They should carry binoculars.
- The survey team will leave the camp early in the morning. For reasons of visibility, it is best to carry out the data collection between 07:30 am in the morning and 04:00 pm in the afternoon.
- The survey should not be done when it is raining heavily, since this will impair the perception of cues. If it starts raining while you are already on the transect, you will have to stop and continue after rain.
- Usually a transect is surveyed from the starting point (0m) to the end (for example 2000m). However, if it is easier to reach the ending point from the camp, you can also start from the end. You will have to make a note on the survey direction on the data collection sheet (see below).
- Begin your observations at point 0m (or the ending point) and fill the data recording sheet, which is explained in detail below.
- Every part of the transect line must be surveyed. Sometimes the line will lead through Uapaca roots or across a big rock, but as long as you don't have an insurmountable object (for example such as a huge Ekki tree) you have to follow the line. Do not take detours because it's more convenient!
- No signs should be missed. Take time and walk the transect slowly, and stop to listen for animals regularly (e.g. every 50m). Search carefully for animals and signs on the ground and in the canopy, to make sure that you don't miss anything. Pay attention especially to the following situations:
  - Objects directly above your head are easily missed, so the 2 trackers focusing on the canopy must check regularly the area directly above them
  - Walking uphill/downhill: When you walk uphill your view and eye-level is more focused on the ground and you might easily miss objects in the canopy. When you walk downhill your view and eye-level is more focused on the canopy and therefore you might easily miss objects on the ground. So all trackers should regularly turn around and look back in order to check the whole range of vision.
- Do not leave the line to follow animals or to see signs beyond your view. All observations must be visible from the transect line. Leaving the trail violates the assumptions of transect sampling and may alter the results. Once you have made an observation from the line, it is of course allowed to leave the line to make accurate recordings (e.g. you see a chimpanzee nest from the line, you then leave the line to make your recordings).
- Do not smoke or talk loudly while walking transects.

The data collection form is attached in Annex 2C. Figure 10 shows an example section to illustrate the explanations below.

CF Site: BIOMONITORING DATA COLLECTION SHEET Month/Year:

Date:			Start Point:	Weather data - take records every hour use one of the following numbers for clouds, rain and wind: 0, 1, 2 or 3 (0=none, 1=small, 2=medium, 3=heavy)										
Transect No:			Start Time:	Time:										
Team:			End Time:	Clouds:										
Data recorder:			Number of sheets:	Rain:										
				Wind:										

No.	Time	Meter	Species	Type of sign	Number ind / nests	Age of sign	Remarks

Fig. 10. Example section of the data collection sheet

3.5.1 EXPLANATION

Headlines

CF Site:

Self-explanatory (for example Sayee CF)

Month/Year:

Self-explanatory (for example 03/2014 if monitoring takes place in March 2014)

Date:

Self-explanatory (Day/Month/Year)

Transect No.:

Self-explanatory (for example T04)

Team:

If there are several Field Teams in one CF site, indicate which Team (for example Team 1)

Data Recorder:

Name of person who is filling the data sheet

Start Point:

0m or 2000m (in case transect length is 2 km)

Start Time:

The time when you start the survey at the start point

End Time:

The time when you reach the end point and the survey is finished

Number of sheets:

In case you fill more than one sheet for data recording along one transect, at the end of the survey write down how many sheets you have used

Weather data:

Record the weather conditions at the start time and then every full hour. Choose one of the following numbers (0-3) to describe clouds, rain and wind:

	Clouds	Rain	Wind
0	no clouds, sky clear	no rain	no wind, calm
1	lightly overcast	light rain	breeze
2	medium overcast	medium rain	more windy
3	heavily overcast	heavy rain	storm

Columns

No.:

Every observation you make along the transect will get a number. Start with 1 and then continue with 2, 3, 4, 5,…… etc.

Observation refers to a single species encounter, i.e. **either** signs of one of the listed animal species **or** signs of humans **or** fruits/flowers (see below under the explanation of **Species**). You have to make sure that you *don't give different or more numbers to the same observation*.

For example, the first observation you make along your transect is that you see a group of Diana Monkeys. You will start filling your sheet with No. 1 and then fill all the other rows related to this observation (i.e. time, meter etc.). Let's assume the Diana Monkeys flee away from you, into the same direction as your transect line is running. If you encounter Diana Monkeys again after 50 m, you should not record them again, because you can be pretty sure that it is the same group which you have already recorded. So make sure that you don't record the same individuals several times on your data sheet.

If for another example you encounter Diana Monkeys and Campbell's Monkeys together at the same time, then every species gets its own number (e.g. No. 1 Diana Monkeys, No. 2 Campbell's Monkeys).

Time:

Note the time of your observation (hour:minutes)

Meter:

Note where on the transect line you are. Use the number of the nearest 50m mark. For example if you find some tracks at 1,790m, your nearest mark would be 1,800m.

Species:

This column refers to one of the following observations:

1. One of the indicator animal species on the biomonitoring list (see Annex 3): fill in the English name
2. Human signs: fill in "Human"
3. Fruits or flowers: in case you find fruiting or flowering trees along the transect, fill in the name of the tree; if possible the English or Scientific name, if not then fill in the local name

Type of sign:

Use the following abbreviations (this is just a guidance and flexible; other codes could be used if more convenient, but make sure to use distinct and unique codes for each sign; likewise, additional signs could be included where necessary)

- **SEE** for see: you see the animal or a human
- **HEA** for hear: you hear an animal or human voices
- **TRA** for tracks: animal or human footprints
- **DUN** for dung
- **NES** for chimpanzee nests
- **NCS** for chimpanzee nut cracking sites
- **ROA** for roads: elephant road, hunting road
- **CAM** for (hunting) camps
- **FAR** for farms
- **GUN** for gun (in case you find a gun, but don't see anybody)
- **GUS** for gun shot (you hear a gun shot)
- **HAR** in case people were harvesting any forest product (for example a piece of bark, or cut a stick to harvest fruits or rattan etc. Specify the plant species and part that was harvested in the last column "Remarks")
- **SHE** for gun shells
- **WIR** for trap wires (snare traps)
- **FRU** for fruits
- **FLO** for flowers
- **OTH** for any other sign (for example burrows, feathers, eggs, bones, fishing nets etc.; specify in the "Remark" column)
- *Note*: In case you find more than one type of sign, you should only record <u>one of it in this column</u>, but make a remark of the other signs in the last column (**Remarks**). For example, if you find fresh duiker dung, you will most probably also see the footprints. Or if you find a

fresh elephant road, you will also see footprints. Or if you see monkeys some of them will also shout. To help you making a decision which of the signs you should fill in the column **Type of sign**:

- *See is more important than hear or tracks*
- *Dung is more important than tracks*
- *Chimpanzee nests are more important than their dung or tracks*

So for example, if you find elephant dung and footprints, here you fill in **DUN** (for dung), and in the column **Remarks** you note dung and tracks

Number of individuals/nests:

The number you have to enter here depends on your type of sign:

- **See:** How many animals / humans do you see? In case you cannot count all, give an estimate (e.g. you encounter a group of monkeys and can see 3 individuals, but you know there must be at least 5, fill in 5).
- **Hear:** How many individuals do you hear calling or talking? **Do not** count the number of calls themselves. Again, if it is difficult to count the individuals try to estimate their number (e.g. if a group of Red Colobus is vocalizing, it will be difficult to distinguish the individuals)
- **Tracks:** The tracks you see are from how many individuals? **Do not** count the number of footprints.
- **Dung:** The dung you see was produced by how many individuals? **Do not** count the number of dung pellets.
- **Nests:** If you see chimpanzee nests, it is important and allowed that you leave the transect line to make sure that you can find and count all of them. Chimpanzees live in groups, and the number of nests can give us an idea of their group size. Sometimes it is not possible to see <u>all</u> nests of one group from the transect line. So in this special case, as soon as you can see one or a few nest from your transect line, it is allowed to leave the transect line to find more. Fill in the number of all the nest you find.
- **Gun:** How many guns do you find?
- **Gun sound:** How many gun shots do you hear?
- **Gun shells:** If you find empty gun shells, count them and **<u>also collect</u>** them
- **Wire:** How many wire traps? Count and **<u>collect</u>** them
- **Fruits:** How many fruits do you count? If there are too many (e.g. more than 50) so that it will take too much time to count them, just enter an estimate, based on 50-scaled intervals (i.e. 100, 150, 200 etc.)
- **Flowers:** How many flowers do you count? If there are too many (e.g. more than 50) so that it will take too much time to count them, just enter an estimate, based on 50-scaled intervals (i.e. 100, 150, 200 etc.)

Age of sign:

We estimate how fresh or old signs are in case of:

1. Dung
2. Chimpanzee nests and nut cracking sites
3. Tracks
4. Roads
5. Camps
6. Farms
7. Gun shells
8. Wires
9. Fruits
10. Flowers

We will use the codes 1 - 4 for the classification of all signs, but these numbers will have a special meaning depending on the type of sign (see Table 1 below). This is necessary because there are international standards, especially in the case of elephant dung and chimpanzee nests. It is important to use the same codes to make sure that data are comparable with data from other biomonitoring programs.

It is therefore crucial that before you allocate an age number to your observation, you check the table and decide, which description is the right one for the age of your sign.

Remarks:

Here you will record additional notes, such as:

- If you have more than 1 type of sign of the same observation, you make a note on the second type here (for example you find elephant dung and footprints, you will enter **DUN** in the column "Type of sign" and Tracks in the Column "Remarks")
- **FAR**m: If you encounter a farm, add some notes on its use (what kind of crops are/were grown) and extent, for example estimate the size and / or by how many people it is/was used
- **HAR**vesting signs: Specify the plant species and the pieces that were harvested. Note also if the plant has been "killed" (its stem totally cut through)
- "Other" signs: If you have entered **OTH** for "Other" in the Column "Type of sign" make a note here what kind of sign it is (e.g. feathers, eggs etc.)
- Any other important notes you need to add to your observation

TABLE 3.1. AGE CLASSIFICATION OF SIGNS

Sign	Age class			
	1	2	3	4
Elephant dung	All balls are intact	One or more balls (but not all) are intact	No balls are intact, but there is still dung material left and sticking together (e.g. plant fibres are hold together by dung material)	No dung material is left, only traces such as plant fibres remain
Other dung	Fresh - sometimes still warm, smell and a sheen (from fatty acids) still present	Recent - Smell might still be present, but no sheen anymore, overall form still intact, no mould	Old - no smell, may have mould, overall form breaking down	Very old - crumbling, dispersed, tending to disappear, covered by leaf fall
Chimp nests	Fresh - all leaves are green and generally dung or urine smell is found under the nest	Recent - most leaves are still green, but also drying leaves of different colours present, no dung or urine smell under the nest	Old - most leaves dry/brown, but the form of the nest is still largely intact	Very old - no or only few leaves left, nest has lost its main form, but is still identifiable by remaining twigs
Chimp nut cracking site	Fresh – less than a week	Recent – less than 1 month but more than 1 week	Old – between 1 and 6 months	Very old – more than 6 months
Tracks	Fresh - less than 1 day	Recent - less than 1 week (but more than 1 day)	Old - less than 1 month (but more than 1 week)	Very old - more than 1 month
Elephant road	Used during the past few days	Recently used - not during the past few days, but within the last month	Old - not used for more than 1 month	Very old - not used for more than 6 months
Hunting road	Fresh - very fresh cuttings present	Recently used (e.g. during the last week)	Old - not in use for more than 1 month	Very old - not in use for more than 6 months
Camps	In use	Abandoned, but recently used	Old - not in use for more than 1 month, but structures (i.e. sticks for tent etc.) still present	Very old - structures rotten or not present anymore
Farms	In use	Recent – used during the latest farming season	Old – more than 1 year or 2 seasons ago	Very old – more than 5 years ago
Gun shell	Fresh (between 1 day and 1 week)	Recent (between 1 week and 1 month)	Old (more than 1 month)	Very old (more than 6 months)
Wire	Fresh (between 1 day and 1 week)	Recent (between 1 week and 1 month)	Old (more than 1 month)	Very old (more than 6 months)
Fruits	Most fruits are unripe	Most fruits are ripe, but not fermenting yet	Most fruits started fermenting	Most fruits rotten
Flowers	Most flowers fresh	Most flowers in an initial stage of wilt	Most flowers shrivelled	Most flowers rotten

When you have reached the ending point and completed the monitoring of a transect line, enter the end time and number of sheets in the respective cells of the data collection sheet. Store the data sheet in a plastic map (clear bag) to protect it from rain or any other damage. On the way back to camp, the data collection team has to maintain the transect line properly where necessary, for example clear re-growing vegetation, cut fallen sticks which are blocking the line etc. This should **not** be done during the data collection (only the most necessary clearing to allow movement of the team), as it might cause noise and distract recorders from observations. After each field trip the data collection sheets should be handed over to the Field Assistant.

CF Site: Kortor CF — BIOMONITORING DATA COLLECTION SHEET — Month/Year: 03/2014

Date: 28/03/2014	**Start Point:** 0m
Transect No: T14	**Start Time:** 07:52
Team: John, Joe, Tim, Prince	**End Time:**
Data Recorder: John Darwin	**Number of sheets:**

Weather data - take records every hour
use one of the following numbers for clouds, rain and wind: 0, 1, 2 or 3 (0=none, 1=small, 2=medium, 3=heavy)

Time:	07:52	9:00	10:00	11:00	12:00	13:00				
Clouds:	2	2	2	2	1	1				
Rain:	0	0	1	0	0	0				
Wind:	1	1	1	1	1	0				

No.	Time	Meter	Species	Type of sign	Number ind / nests	Age of sign	Remarks
1	07:58	0	Black-casqued Hornbill	HEA	1	-	
2	08:18	150	Maxwell's Duiker	SEE	1	-	
3	08:56	200	Bay Duiker	TRA	1	2	
4	09:24	400	Maxwell's Duiker	TRA	2	1	
5	10:15	550	Chimpanzee	NES	3	1, 2	and dung age 2 below one nest
6	11:08	600	Bay Duiker	DUN	1	3	
7	11:20	650	White-crested Hornbill	HEA	1	-	
8	11:44	800	Elephant	DUN	5	2, 3	and tracks, roads and feeding signs
9	12:30	1000	Human	SHE	1	2	
10	13:27	1150	Diana Monkey	SEE	7	-	
11	13:27	1150	Red Colobus Monkey	SEE	5	-	

Fig. 11. Example of how to fill the data collection sheet.

Figure 11 shows an example of how to fill the data recording sheet for the following scenario:

- On the 28th of March 2014, the four trackers of the Kortor CF Field Team carry out the biomonitoring data collection along Transect No. 14 in the Kortor CF. John Darwin is the Team Leader and also responsible for the data recording.
- They start the survey from the starting point at 07:52.
- Before starting observations they record the weather data (medium overcasts, no rain, breeze), and repeat this every full hour.
- At 07:58, they are still close to the starting point, they hear a Black-casqued Hornbill.
- At 08:18, at approximately the 150m mark, they see a Maxwell Duiker on the left side of the transect.
- At 08:56, around the 200m-mark, they find tracks of one Bay Duiker. The animal passed this area recently, that is more than 1 day but less than 1 week. Tim reminds everybody not to forget the weather data recording at 9:00am.
- At 09:24, they find fresh tracks of 2 Maxwell's Duikers. They check for the nearest 50m-mark which is 400m.

- At 10:15 the trackers encounter a fresh chimpanzee nest, not far from the 550m mark. Under the nest they find some dung of age class 2, so John makes a note on that in the "Remarks" column. They carefully check the surrounding area and discover two more nests, one also age class 1, and another one of age class 2.
- At 11:08 they find Bay Duiker dung, of one individual and age class 3. The nearest mark is the 600m sign.
- A few minutes later, at 11:20, close to 650m, they hear a White-crested Hornbill.
- The next observation along the transect is elephant dung between the 800m and 850m mark, at 11:44. Obviously it was a group, who was feeding in the area. In total the trackers find dung of 5 different individuals and several other signs such as tracks, feeding signs, and roads. These additional observations are entered in the column "Remarks". The consistency of the dung is classified as either age class 2 or 3.
- At 12:30 at around 1000m, the field team finds an empty gunshell. They think it was fired between one week and one month ago, and rate its age as class 2.
- At 13:27, at approximately 1,150 meter transect length, the team sees a group of Diana Monkeys, mixed with Red Colobus Monkeys. Since the monkeys get alert and flee, the team does not have much time to observe and count the animals. They count at least 7 Diana Monkeys, and 5 Red Colobus Monkeys.
- etc.

3.6 STEP 6: DATA STORAGE AND MANAGEMENT

***Note*:** *This handbook cannot replace a computer training course. It is assumed that the Program Coordinator, and in part the Field Assistants, have basic computer skills. In particular, the minimum requirement is that they understand and know how to operate Windows Explore folders, as well as the main basic functions of Word and Excel.*

A good data management system is vital and will facilitate data storage, location and handling. A well-thought arrangement should be in place already before starting field data collection. Use a system of folders and subfolders for organizing your different types of data and files. What will be your key categories? Think about main fields such as geographic and thematic aspects. If helpful, make a list on a piece of scrap paper first and then arrange suitable kind of data types to groups, and summarize several groups to categories, before creating the system in the Windows Explorer folder on the computer. An example is shown in Figure 12. Data organization however is also a matter of personal taste, and everybody has his/her own preferences, so the example below just serves as a general guideline. Note also that the system is not fixed, and can be restructured any time, in case you find a more convenient scheme over time.

All data collected in the field should be transferred or entered into the computer as soon as possible after the field trip. These data are called "raw" data and represent the original data sets, which you will then use to work with. In order to avoid any loss of these original (and other) data, it is highly recommended to (i) carry out regular backups (that means storage of a copy of all data for example on an external hard disc) and (ii) before starting to work on the original data, always save the file under a different name.

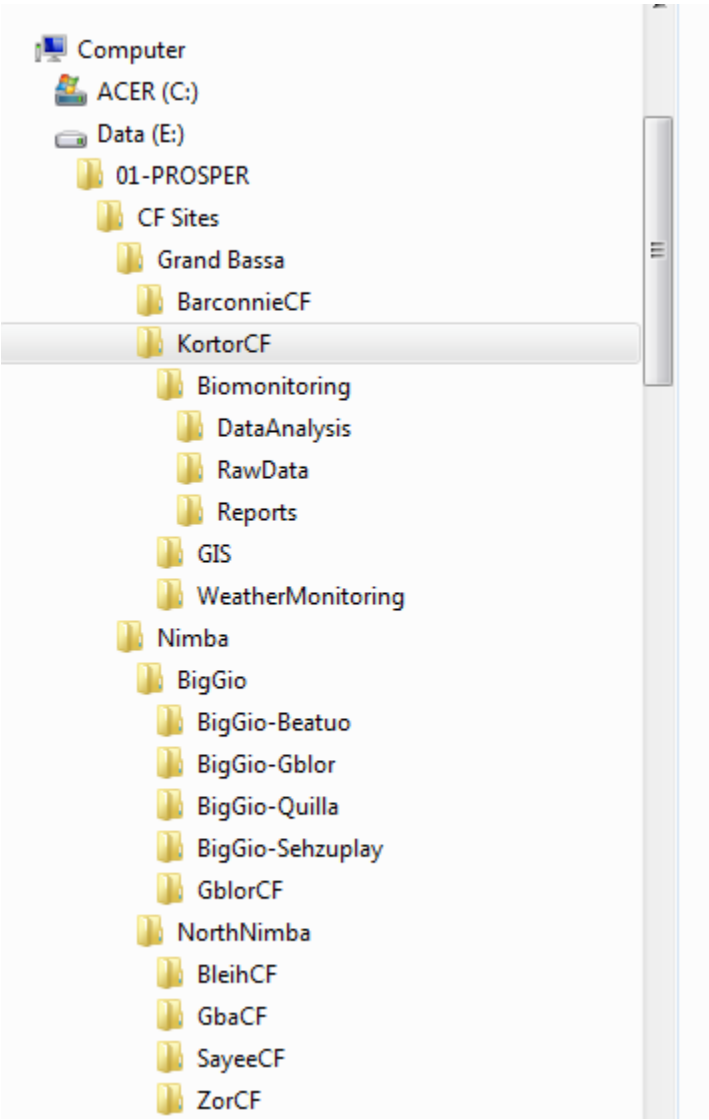


Fig. 12. Example for data management system using the Windows Explorer. In this case data are first of all grouped geographically, i.e. by county, and then by CF site. Within each CF-site folder, three subfolders were created (see exemplified for the Kortor CF): Biomonitoring, GIS and Weather Monitoring. The Biomonitoring folder, again, contains three main categories: DataAnalysis, RawData and Reports.

A well-structured organization is not only important for the overall data management, but also applies to the data entry. In some cases the data might be entered in the same form as they were collected in the field, which means that the data collection sheet and the data entry sheet are the same. This applies (in this handbook) for example to the weather data. In other cases, however, the data entry template needs to be arranged differently, in order to facilitate the analysis. Hence it is recommended to spend some time and think about how the data will be analysed, in order to create a suitable data entry template, which will help to save a lot of time later on. The monitoring program as presented in this handbook will produce three main data sets:

1. Weather data
2. Habitat description data
3. Biomonitoring data

All data will be managed and analysed in Microsoft Office Excel. Examples for how to prepare the raw data entry templates are shown below (Figures 13-15).

The weather data will be entered in the same form as they are collected (Figure 13, Annex 2B). In Excel, create a file as shown in Annex 2B, and within the file one sheet for each month. At the end of each month, transfer the data that were collected by the community members to the computer.

	A	B	C	D	E	F	G
1	Location:			Month:			
2	Date	Humidity %		Temperature ° C		Rainfall mm	
3		max	min	max	min		
4	1						
5	2						
6	3						
7	4						
8	5						
9	6						
10	7						
11	8						
12	9						
13	10						
14	11						
15	12						
16	13						
17	14						
18	15						
	16						

January 2013 | February 2013 | March 2013 | April 2013 | May 2013 | June 2013 | July 2013

Fig. 13. Example for weather data entry sheet.

For the habitat description data entry, see the example in Figure 14. You could add more columns, if necessary. For example between “CF Site” and “Date” you could insert “Area” if you wish to be more specific about the area within the CF site. This might be particularly the case for larger sites such as the Big Gio Forest. An important principle of Excel is that it attributes parameters to cells, which are clearly defined by column and row, and thus that you use one cell per data information. This will make it easier to analyze the data later and allow, for example, to filter data.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	County	CF Site	Date	T-No.	Meter	Type	Tree species	Tree height	Lianas	Canopy cover %	Ground cover %	Level	Elev.	Water resources	Notes
2															
3															
4															
5															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	County	CF Site	Date	T-No.	Meter	Type	Tree species	Tree height	Lianas	Canopy cover %	Ground cover %	Level	Elev.	Water resources	Notes
2	Nimba	Sayee	02/11/2013	1	0	PF	MIX	35	2	75	75	S up	268		0588120----0611367
3	Nimba	Sayee	02/11/2013	1	50	PF	MIX	35	2	75	75	S down	291		
4	Nimba	Sayee	02/11/2013	1	100	PF	MIX	30	2	50	50	S up	277		
5	Nimba	Sayee	02/11/2013	1	150	PF	MIX	30	1	50	50	Ridge	270		
6	Nimba	Sayee	02/11/2013	1	200	PF	MIX	35	1	50	75	S down	240		
7	Nimba	Sayee	02/11/2013	1	250	PF	MIX	25	2	50	75	S down	255		
8	Nimba	Sayee	02/11/2013	1	300	PF	MIX	30	3	50	75	S down	252		
9	Nimba	Sayee	02/11/2013	1	350	PF	MIX	30	3	50	75	Level	260	stream	
10	Nimba	Sayee	02/11/2013	1	400	PF	MIX	25	2	75	50	S up	275		
11	Nimba	Sayee	02/11/2013	1	450	PF	MIX	25	3	75	75	S up	272		
12	Nimba	Sayee	02/11/2013	1	500	PF	MIX	25	3	50	50	Ridge	274		
13	Nimba	Sayee	02/11/2013	1	550	PF	MIX	25	2	75	50	S down	268		
14	Nimba	Sayee	02/11/2013	1	600	PF	MIX	30	2	50	75	S up	291		tree fall
15	Nimba	Sayee	02/11/2013	1	650	PF	MIX	30	3	75	75	S up	266		
16	Nimba	Sayee	02/11/2013	1	700	PF	MIX	30	3	50	75	Ridge	267		

Fig. 14. Example for how to prepare (top) and fill (bottom) the habitat description data entry sheet.

The biomonitoring data entry is a bit more complex and will be explained more in detail below. Figure 15 shows an example template. It is composed of 17 columns. Again, this is flexible and you could insert additional columns such as the starting point, starting time and ending time. However, always think about the information value of the data you enter – as it will also take time.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Row	CFS	Area	Day	Mon	Year	Rec	T-No	Time	Met	Spec	Sign	Num	Age	Clo	Rain	Wind
2																	
3																	
4																	
5																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Row	CFS	Area	Day	Mon	Year	Rec	T-No	Time	Met	Spec	Sign	Num	Age	Clo	Rain	Wind
2	1	Kortor	2	28	3	2014	JD	14	07:52	0	na	na	na	na	2	0	1
3	2	Kortor	2	28	3	2014	JD	14	07:58	0	Black-casqued HB	HEA	1	na	na	na	na
4	3	Kortor	2	28	3	2014	JD	14	08:18	150	Maxwell's Duiker	SEE	1	na	na	na	na
5	4	Kortor	2	28	3	2014	JD	14	08:56	200	Bay Duiker	TRA	1	2	na	na	na
6	5	Kortor	2	28	3	2014	JD	14	09:00	na	na	na	na	na	2	0	1
7	6	Kortor	2	28	3	2014	JD	14	09:24	400	Maxwell's Duiker	TRA	2	1	na	na	na
8	7	Kortor	2	28	3	2014	JD	14	10:00	na	na	na	na	na	2	1	1
9	8	Kortor	2	28	3	2014	JD	14	10:15	550	Chimpanzee	NES	3	1	na	na	na
10	9	Kortor	2	28	3	2014	JD	14	11:00	na	na	na	na	na	2	0	1
11	10	Kortor	2	28	3	2014	JD	14	11:08	600	Bay Duiker	DUN	1	3	na	na	na
12	11	Kortor	2	28	3	2014	JD	14	11:20	650	White-crested HB	HEA	1	na	na	na	na
34	33	Kortor	2	29	3	2014	JD	15	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*

Fig. 15. Example for how to prepare (top) and fill (bottom) the biomonitoring data entry sheet.

The filled part in Figure 15 refers to the example that was given at the end of section 3.5, see also Figure 11.

Transfer the data from the data collection sheet as follows:

Row:

This is the general numbering you should use to identify all entries you will make in the course of time. Start with 1 and then continue ascending. Each row gets a distinct number, no number can appear twice. Note that this does **not** refer to the "**No**." of the data collection sheet (which will not be entered in the raw data sheet)

CFS:

CF Site

Area:

In case the CF site is divided in several areas. In the example above we assume that Kortor CF is monitored by 2 different teams and that T14 lies within Area 2

Day, Mon, Year:

Date of the survey; use one column each for the day, month and year

Rec:

The name of the data recorder. You may use abbreviations, as long as they are distinct and unique

T-No:

Transect number

Time:

The time of the observation as recorded in the data collection sheet

Met:

The nearest 50m mark as recorded in the data collection sheet

Spec:

The species as recorded in the data collection sheet. It is allowed to use the English name and some distinct and unique abbreviations (for example HB for hornbill, W-B Guineafowl instead of White-breasted Guineafowl etc.), as long as it will not create any ambiguity

Sign:

Type of signs. Use the same abbreviations as outlined in section 3.5

Num:

Number of individuals/nests as recorded in the data sheet

Age:

Age of sign as recorded in the data collection sheet. If more than one age class was recorded enter the most recent one.

Clo, Rain, Wind:

Weather data as recorded in the data collection sheet, enter each parameter in an extra column

There are some general aspects that need to be considered for the raw data entry:

- Every cell has to be filled, there must not be any blank cells in the spreadsheet. In case you cannot attribute any information to a cell, enter "na" (which stands for "not available"). This applies for Meter, Species etc. when you enter the weather data, and for the weather data when you enter your observations. In case the Field Team forgot to fill a cell in the data recording sheet, you will also fill "na" for the missing information. A special case is given if no observation was made along a transect. If this happens it has to be indicated somehow in the data entry sheet, because the transect was surveyed and hence its distance has be to taken into account in the overall analysis. You will fill one row and enter the general information that is available (Row, CF Site, Area, Date, Transect number, Data recorder), and "*nil*" in the remaining cells. In the example above, Figure 15, the team surveyed Transect No. 15 on the 29th of March 2014, but did not find anything. You do not have to fill the weather data in this case.
- If a transect, for whatever reason, was not surveyed at all, do not make any entry in the data sheet.

3.7 STEP 7: DATA ANALYSIS AND REPORT

After data are collected they need to be analysed and interpreted, and then made available to fellow managers or researchers in the form of a report. This chapter deals with some general recommendations and examples how to analyse and present the data.

3.7.1 WEATHER DATA

Weather data usually are analysed per month. Do the following:

1. Determine the average temperature for each month

   Add all daily maxima and divide by the number of days to determine the average monthly maximum. Do the same for the minima. Then add the average monthly maximum and minimum, and divide by 2. The result is the average monthly temperature.

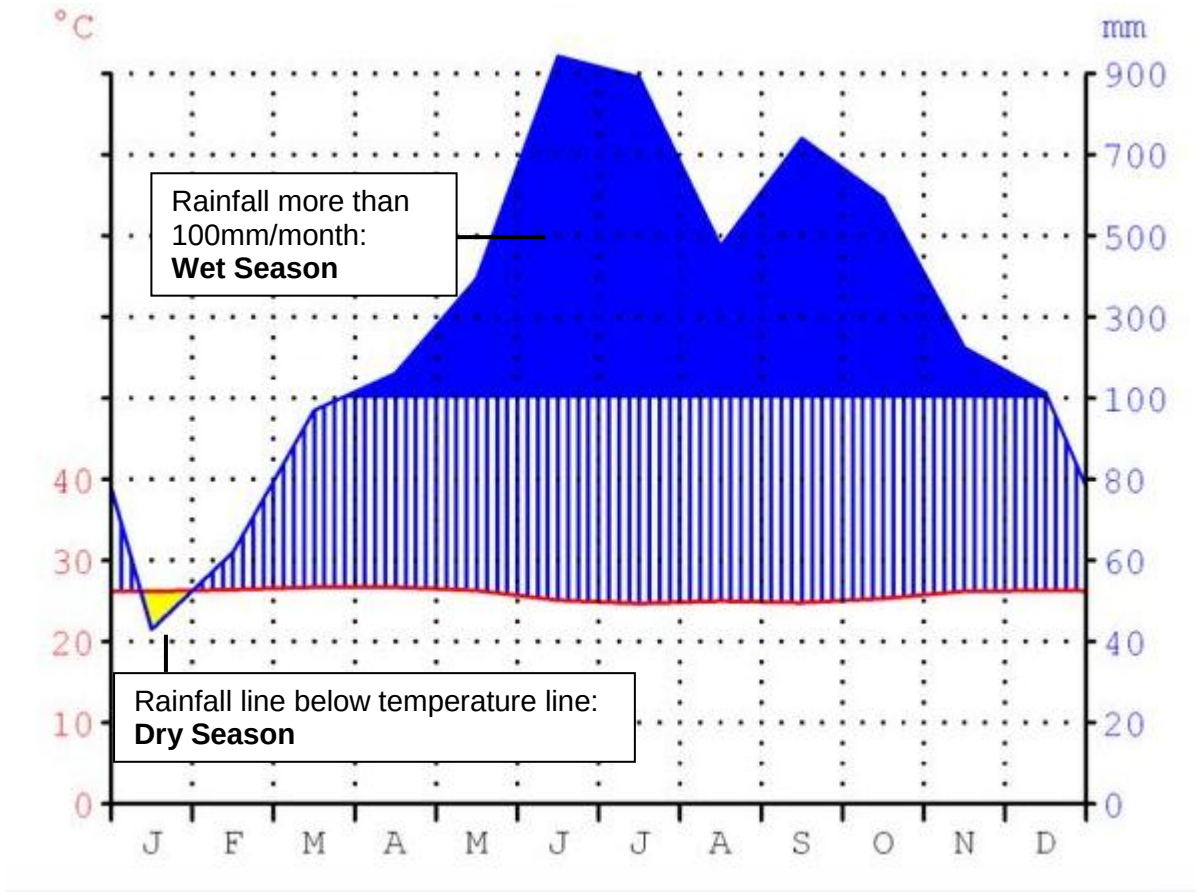
2. Determine the total amount of rainfall for each month, by adding up all daily rain fall amounts.

3. Draw a graph

   Put a scale for rainfall on the right-hand and a scale for temperature on the left-hand. Each 10 degrees in temperature should be the same height as 20mm in rainfall. For areas with high rainfall as in the tropics, the interval of the rainfall scale can be larger above 100mm, for example increase to 200mm-steps. List the months along the horizontal axis (see example on the next page).

4. Plot monthly data (average temperature and rainfall) on the graph

   Example of weather data of Monrovia:

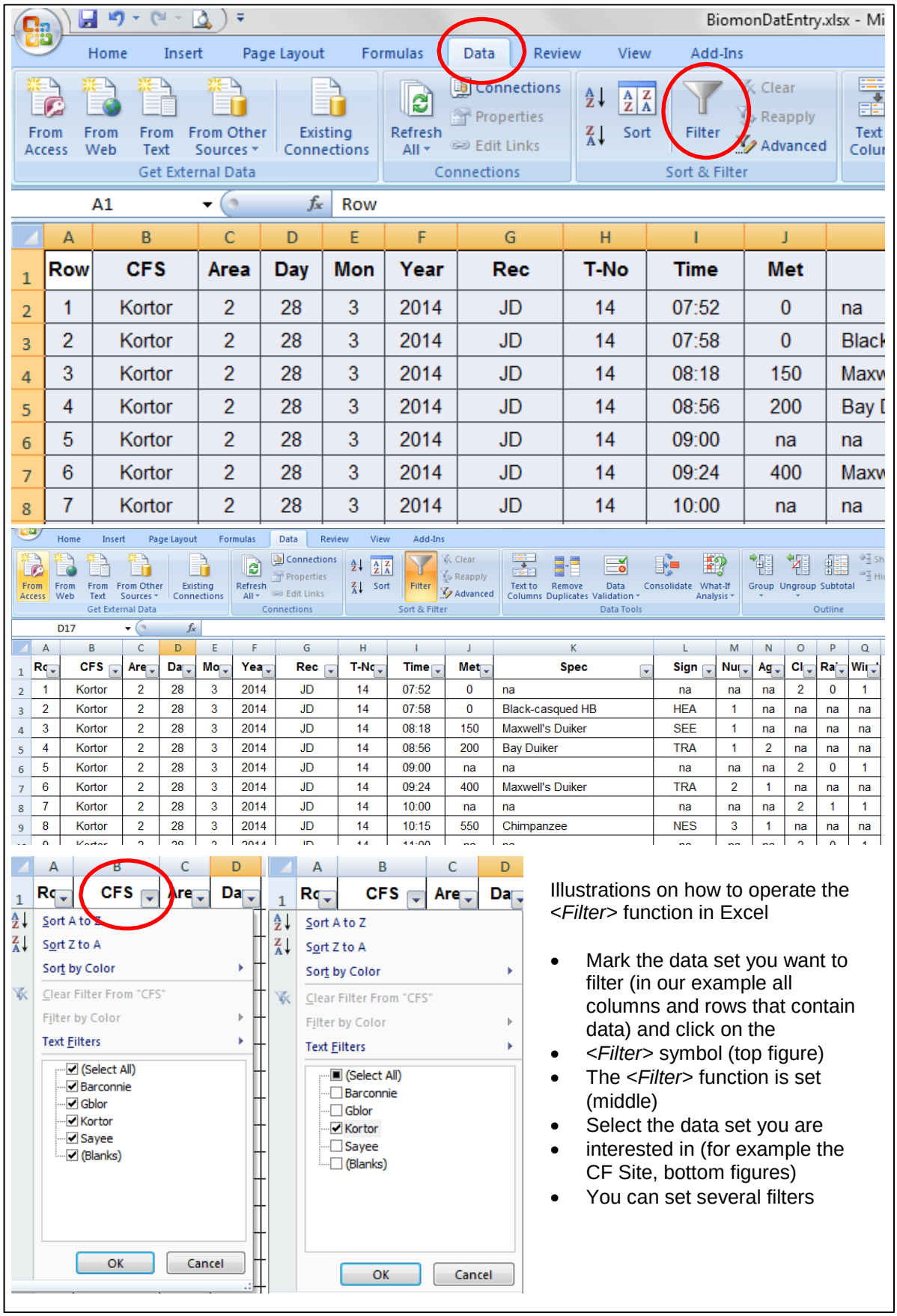


The calculations and graph can be done in Excel or by hand.

3.7.2 BIOMONITORING DATA

Note: *Before starting any analyses with your data, open the raw data file and immediately save it under a new name in the Data Analysis Folder, to make sure that you do not lose the original data*

The two main tools that will help to analyse the biomonitoring data are the <*Filter*> and <*Pivot Table*> functions in Excel. The <*Filter*> function is found in the Table "Data" (see illustration below). Before you select it you have to mark or highlight the data set you want to work on. As soon as you have clicked the <*Filter*> symbol, it will be highlighted in orange and the head columns of all the selected data sets will show a small drop-down arrow ▼. If you click on it, a drop-down menu will appear and you can select the data set you are interested in. It is possible to set several filters simultaneously. For example, if you are interested if in 2014 there were any elephants recorded in the Kortor CF, then select the Year (2014), the CF Site (Kortor) and the Species (Elephant) by using the <*Filter*> on these three columns.



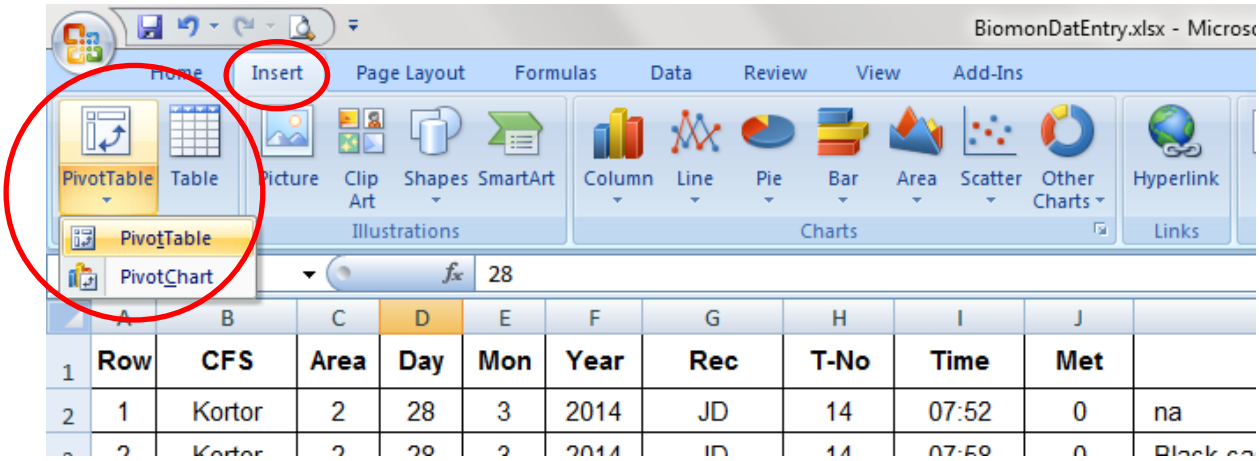
Row	CFS	Area	Day	Mon	Year	Rec	T-No	Time	Met	
1	Kortor	2	28	3	2014	JD	14	07:52	0	na
2	Kortor	2	28	3	2014	JD	14	07:58	0	Black
3	Kortor	2	28	3	2014	JD	14	08:18	150	Maxw
4	Kortor	2	28	3	2014	JD	14	08:56	200	Bay [
5	Kortor	2	28	3	2014	JD	14	09:00	na	na
6	Kortor	2	28	3	2014	JD	14	09:24	400	Maxw
7	Kortor	2	28	3	2014	JD	14	10:00	na	na

Ro	CFS	Are	Da	Mo	Yea	Rec	T-No	Time	Met	Spec	Sign	Nu	Ag	Cl	Ra	Wi
1	Kortor	2	28	3	2014	JD	14	07:52	0	na	na	na	na	2	0	1
2	Kortor	2	28	3	2014	JD	14	07:58	0	Black-casqued HB	HEA	1	na	na	na	na
3	Kortor	2	28	3	2014	JD	14	08:18	150	Maxwell's Duiker	SEE	1	na	na	na	na
4	Kortor	2	28	3	2014	JD	14	08:56	200	Bay Duiker	TRA	1	2	na	na	na
5	Kortor	2	28	3	2014	JD	14	09:00	na	na	na	na	na	2	0	1
6	Kortor	2	28	3	2014	JD	14	09:24	400	Maxwell's Duiker	TRA	2	1	na	na	na
7	Kortor	2	28	3	2014	JD	14	10:00	na	na	na	na	na	2	1	1
8	Kortor	2	28	3	2014	JD	14	10:15	550	Chimpanzee	NES	3	1	na	na	na

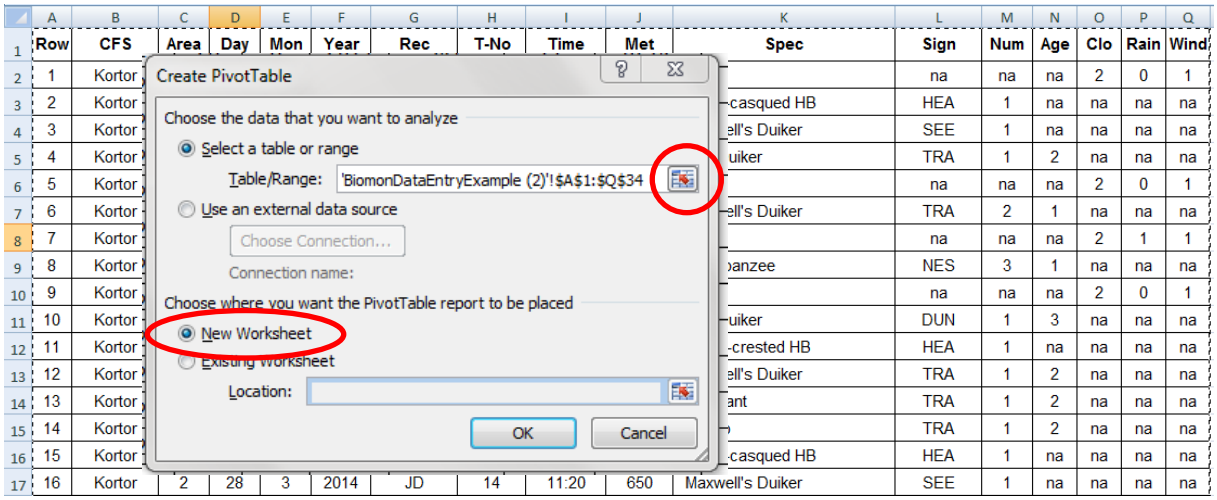
Illustrations on how to operate the <*Filter*> function in Excel

- Mark the data set you want to filter (in our example all columns and rows that contain data) and click on the
- <*Filter*> symbol (top figure)
- The <*Filter*> function is set (middle)
- Select the data set you are
- interested in (for example the CF Site, bottom figures)
- You can set several filters

The <*Pivot Table*> allows more complex analyses. It is based on the same principle of filtering data, but at the same time can be easily used for a variety of calculations, with different combinations of data sets. If for example you would like to know, how many elephant records there were in 2014 in Kortor, what type of signs and the total number of all animal records to calculate the percentage of elephant records, it would be possible but a bit laborious with the <*Filter*> function. The <*Pivot Table*> function is found in the Table "Insert":

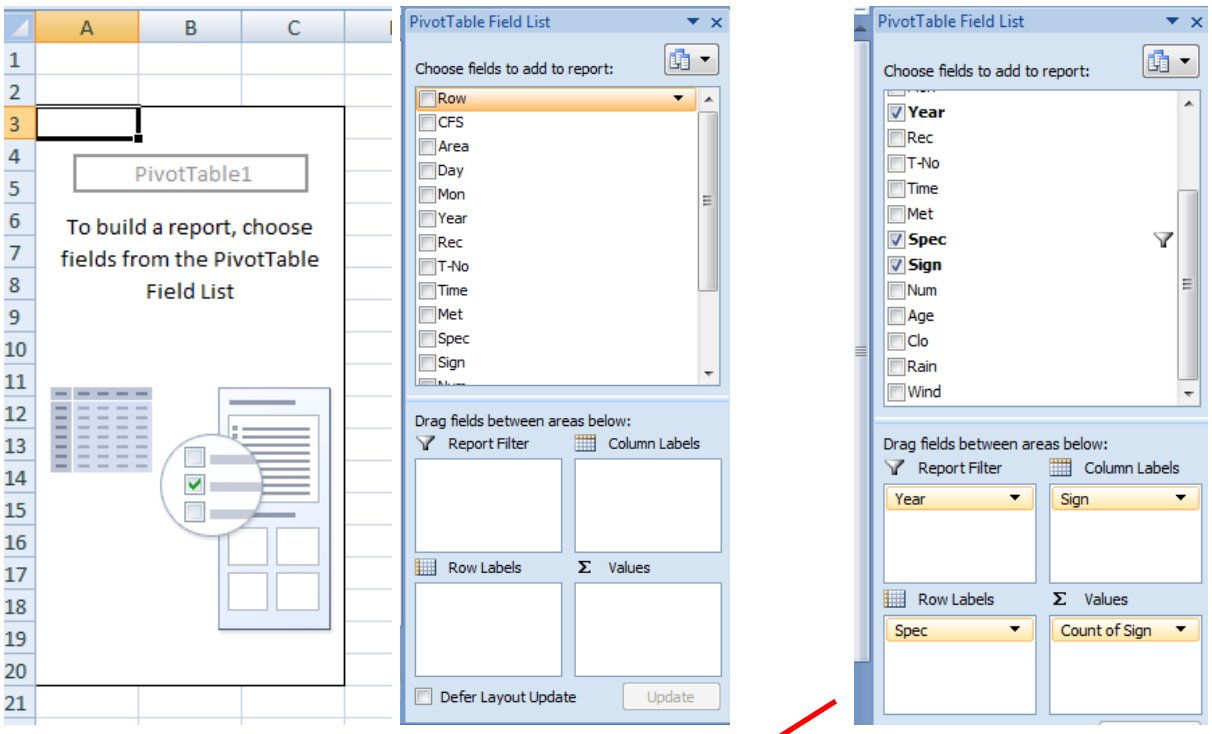


If you select it, a window will pop up and ask you to select the data range, which is the data set you want to work on. The computer automatically selects the whole database of the sheet - and that is also what we usually use -, so if you want to use the complete data set, you don't have to do anything else. In case you want to use just a part of the data, click on the small symbol on the right, then you can select the data in the spreadsheet. In the example below the data range is all data in the cells from A1 to Q34. Before confirming with "OK" make sure that in "Choose where you want the Pivot Table report to be placed" you select "New Worksheet".



A new sheet will be inserted in your file, containing the Pivot Table on the left side, and an operation menu on the right side (see left and middle picture below). The operation menu is divided in two parts: in the upper part you will find the "fields", which correspond to the selected columns of your data sheet. You can choose which one you want to use for the analysis and drag them into the lower section. The

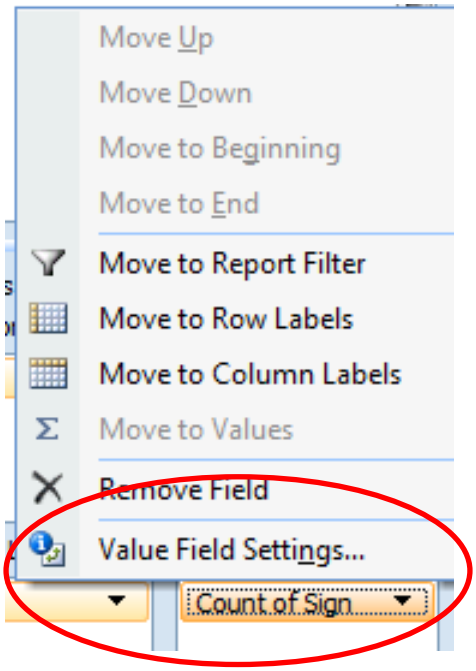
lower section contains the “Report Filter”, which is the main filter, the “Row” and “Column Labels” and the “Values”. The <*Pivot Table*> can be established by selecting on the left the rows’ criteria, on the top the columns’ criteria, and in the main section the values to analyse. If necessary an overall “Report Filter” can be selected as well but is not obligation. To use the Table, drag any of the “fields” into the row or column boxes and into the value box. The following example illustrates how the Table works. We are interested in the species records of 2014, so we choose “Year” as Report Filter, “Species” should be listed in the rows and the “Signs” in the column (see right picture below). The “Sign” will also be dragged into the “Value” field, because we are interested in the number of the different records per species.

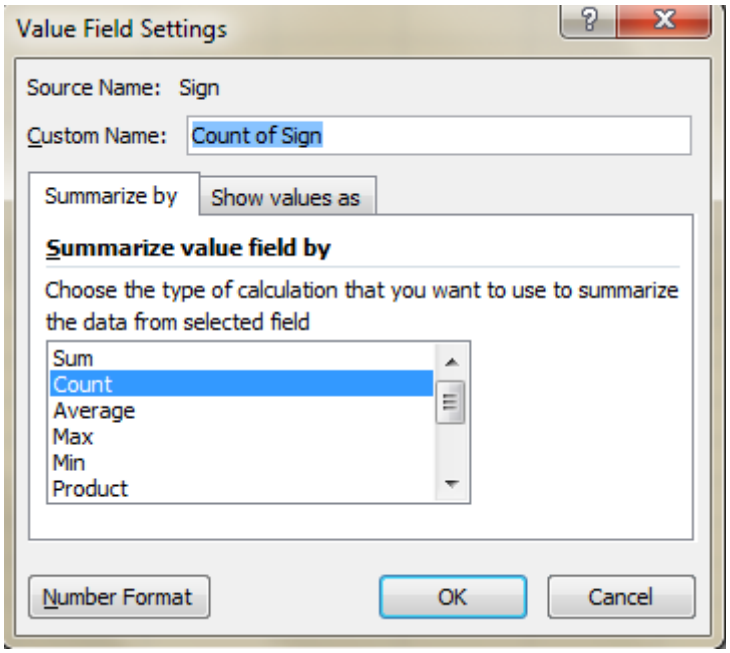


	A	B	C	D	E	F	G	H
1	Year	(All)						
2								
3	Count of Spec	Column Labels						
4	Row Labels	DUN	HEA	na	NES	SEE	TRA	Grand Total
5	Bay Duiker	1					4	5
6	Black-casqued HB		4					4
7	Bongo						3	3
8	Chimpanzee				1			1
9	Elephant	1					2	3
10	Maxwell's Duiker					4	4	8
11	na			4				4
12	White-crested HB		3					3
13	**Grand Total**	**2**	**7**	**4**	**1**	**4**	**13**	**31**

The program by default offers a formula that fits to the data type (in this case “Count”), but you can change the operation formula by clicking on the small arrow ▼ on the right, and in the appearing window you select “Value Field Setting” (left picture below). Another window will pop up and offer you to

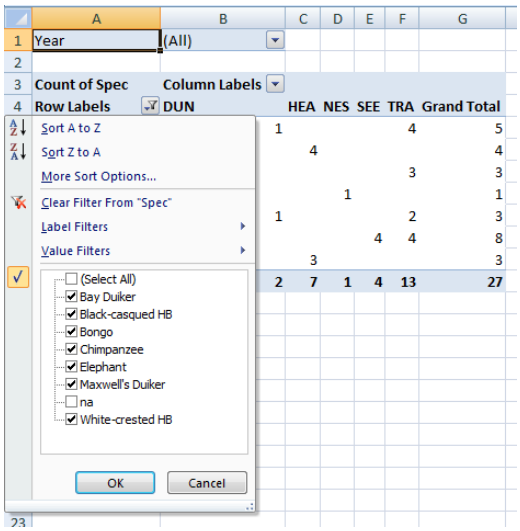
choose amongst a variety of operations such as sum, average etc. (below right). As soon as you start dragging fields into the lower sections in the operation menu you will see that the Pivot Table on the left side shows the data as you have selected them (see picture above). In our example there were in total 31 records: 2 dung, 7 hear, 4 “na”, 1 nest, 4 times see and 13 time tracks, from 7 different species. The “na” refers to the cells of your data sheet where you entered “na” (not available); that means mainly to the rows where you entered the weather data.

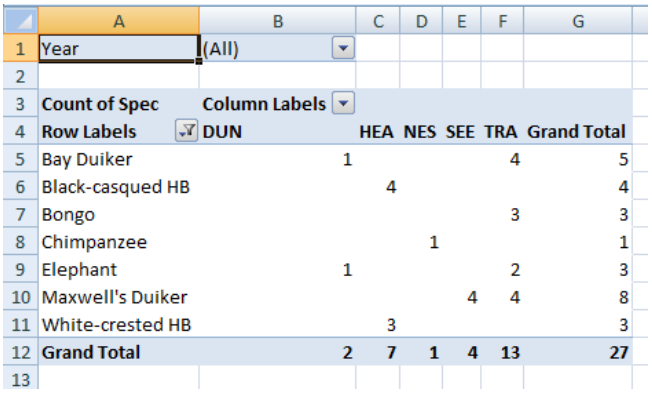




We don’t want the “na” records included in our analysis, because we are only interested in the species encounters (for example to calculate the encounter rates or the percentage of records per species compared to all records). Four of the total records (31) refer to “na”, so it means that there were 27 species records. The Pivot Table is a very convenient tool, as once the table is established, it stills allow you to further filter your data. To eliminate the “na” records, in the Pivot Table just click on the filter sign ▼ next to “Row Labels” and “Column Labels”, respectively, and deactivate “na” from the appearing drop-down menu (see left picture below). You can now see that the table has changed – the “na” has disappeared and the total records are 27 (see right picture below).

Pivot Tables are very efficient to help you with the data analysis and answer your main questions. The results of the outlined example tell us for instance how many species were recorded during biomonitoring in that particular year, what was the most often recorded animal (e.g. the Maxwell’s Duiker with 8 of 27 records, which corresponds to 30%), the most often encountered signs (e.g. tracks, which with 13 out of the 27 records, or 48%, made up nearly half of all signs), what type of signs per species (e.g. the hornbills were only heard, while the presence of elephants was indicated by tracks and dung), and the different species’ encounter rates (as number of records per kilometer. If we assume that the data in the example come from one transect of a length of 2 km, then the encounter rate of the Bay Duiker is 2.5 signs per kilometer, the one of the Black-casqued Hornbill 2 signs per kilometer etc.)





Year	(All)					
Count of Spec	Column Labels					
Row Labels	DUN	HEA	NES	SEE	TRA	Grand Total
Bay Duiker	1				4	5
Black-casqued HB		4				4
Bongo					3	3
Chimpanzee			1			1
Elephant	1				2	3
Maxwell's Duiker				4	4	8
White-crested HB		3				3
Grand Total	**2**	**7**	**1**	**4**	**13**	**27**

There is a huge variety of combination possibilities, and depending on your question you will choose different arrays. If, for another example, you are interested in a certain species, and want to know all records by age class for this species, you would select "Species" as the Report Filter, "Signs" as rows, and "Age" both as columns and in the value field (which will automatically offer "Count" – don't use "Sum" because the numbers you have entered in "Age" in your data sheet are just codes for a certain decay stage and not actual ages in years or months):

Report Filter: Species

	AGE
SIGN	Count of AGE

Or "On which transect was each animal species found?":

No Report Filter necessary

	TRA
SPECIES	Count of SIGN

Or "What animal species were recorded in a particular CF site in different years?":

Report Filter: CFS

	YEAR
SPECIES	Count of SIGN

Or “How many gun shells were collected in the different CF sites in different years?”:

Report Filter: SIGN (and then select SHELL)

	YEAR
CFS	Sum of NUM

It is impossible to cover all kind of potential questions and analyses in this general handbook, but it will outline the key results that should be included in the annual report. The report should be in form of a technical report, and by standard comprise the four main sections: *Introduction*, *Methods and Materials*, *Results*, *Discussion and Recommendations*, as outlined more in detail below. In case the report is a large or long document it is recommended to include a *Table of Contents* and an *Abstract* or *Summary* at the beginning. Further attach appendices at the end of the report to include relevant, but lengthy information such as a list of equipment or the raw data.

3.7.3 GENERAL GUIDELINES FOR BIOMONITORING REPORT

The information for the report must be well presented, that means the report must be well-structured and the information carefully organized, clear, easily understood and interesting. Graphics such as maps, charts, photographs etc. should be used whenever possible to illustrate results. Such visual aids can be an effective way of presenting data in a simple, easily to understand manner, and make the document more appealing to the reader. Use graphs for example to illustrate results such as trends in species abundance, and maps to give an overview of the CF area and location of transects, as well as to show the spatial distributions of species and habitat disturbance etc. Further, arrange key information in suitable data sets in tables for better overview, and explain them more elaborately in the text body. A table or chart should never just be left self-explaining to the reader, but its respective contents should always be clearly described and summarized in the text. Emphasise the most useful information. This will make the report easier and more interesting to read. The report should be structured as follows:

- *Introduction*

  The introduction will provide general background information on the purpose of the biomonitoring program and the content of the report. You could for example write “This report presents the results of the … year biomonitoring cycle in the … CF site. The monitoring program was established under the PROSPER project in order to monitor ….and inform….. etc.“. Particularly in the first report the introduction section will be more elaborate than in the yearly follow-up reports, in which you could refer to the details given in the first report. In case the overall approach undergoes any changes over time, for example to adapt the protocol to site-specific requirements, this also has to be mentioned and explained in the introduction.

- *Methods and materials*

  This section informs on the methods and materials used for the survey, which is not only important for the reader to understand the overall context of data and results, but will also allow him to repeat the survey, for example in another area. Hence this section should be described in enough detail to let someone else duplicate the study. Again, the first report might be more comprehensive than the follow-up reports, which nevertheless must contain the details that apply for that particular monitoring period. For example, the materials used by the Field Teams such as camping and cooking gear, survey tools etc. might remain the same every year, as will the overall approach, e.g. line transect sampling in the dry season. The survey however might not be carried out at exactly the same

dates every year, the number of successfully completed transect lines might vary etc. In general, this section should provide information on

- Dates and times of monitoring cycle
- Location, number and length of transects (a map of the area is always useful)
- Survey effort – how many transect lines monitored, total distance covered
- Data collection method and protocol (detailed in the first report)
- Field Team (if the author(s) of the report is not the only person who collected the data, then the number, name and qualifications of the field team members should be mentioned)
- Data analysis method – provide as much details as necessary to let the reader understand the data sets you have been working with (for example "the calculation of the percentage breakdown of species records is based on the total number of animal records only, after discarding human encounters from the total"; or "the calculation of elephant encounter rates did not include elephant roads of age class 4" etc.)
- A comprehensive list of materials and field equipment. This could be placed in an annex

- *Results*

The raw data set will allow you to carry out a variety of analyses, however not all of them will be relevant to the biomonitoring program's objective. It is important to summarize and present the key results and eliminate negligible information, while the raw data set could be attached in an appendix. The following guidelines will help to select the most significant data:

<u>General overview</u>

- Total number of species recorded
- Total number of records (note that a "record" refers to an observation as explained in section 3.5; it means how often a species has been encountered, but not how many individuals per species were recorded)
- Percentage breakdown of species (how many records per species)
- Type of records and percentage breakdown of record types per species
- Ancillary/optional: number of individuals per species and age classes per sign
- Weather data (the continuously sampled one), presented as explained in the first part of section 3.7 above, could be included as well

<u>Species-specific information</u>

Biological populations usually are assessed in three ways: (a) abundance, (b) distribution across space and season and (c) trends over time. It might not be feasible or necessary to provide these parameter for every single species, but focus on species of particular interest in a given CF Site.

- Spatial distribution: on how many and which transects was the species recorded? Consult and cite the habitat description data as ancillary information on the different areas. Maps should be inserted for illustration. If the monitoring is carried out twice a year, in different season, data can be compared also on a seasonal basis.

- Relative abundance: Calculate the encounter rate per species as number of records per kilometer transect. You have to take into account all transects that were surveyed, even if the species was not recorded along some transects. For example if you have monitored 10 transect lines of 2 km each, the total survey length is 20 km. If in total you have encountered chimpanzees 10 times during the whole survey (for example you found 3 times nests (note: **not** in total 3 nests, but three times, regardless of how many in each case), 1 time you saw them, 4 times you heard chimpanzees, and 2 time you found footprints), the encounter rate is 0.5 signs/km. In some cases it is recommendable to use different data sets for the calculation, for example discard very old signs, which might have been recorded already during the previous survey. This will depend how often the monitoring is repeated. Most signs might not last a year or more, but there are some exceptions, such as elephant tracks, roads, probably also elephant dung, as well as farms and gun shells etc. However, we might be mainly interested in fresh or recent signs, especially when comparing encounter rates of different surveys and years. In that case calculate two sets: one including all records of all age classes per species, and a second encounter rate of "recent" signs (for example discarding elephant roads of age class 4). Encounter rates can further be calculated for different areas of the CF site, by pooling the data from the respective transect lines.
- Trends, that means the species' relative abundance over time. This will be especially interesting in the course of time, after surveys have been undertaken repeatedly and allow a comparison of years/monitoring cycles.

Human impact

- Total number of records
- Type of records
- Age class of records
- Total number of gun shells and wires collected during the survey
- Spatial distribution, encounter rate and trends of human impact as explained above for animal species, but based on human signs

- *Discussion and Recommendations*

Results alone do not have biological meaning until they are put in a biological context. This section is the room for data interpretation, discussion of possible meanings of the results, comparison with other sites and, based on your findings, recommendations for management and conservation implications in the respective CF site. Results of the first monitoring cycle could for example be compared with data from other areas, where available, and as long as comparable methods have been used (for example compare all CF sites). The follow-up reports then will include also the comparison with data of previous surveys (the trends). Some general aspects have to be kept in mind when interpreting data. The results of the study are accurate only for the conditions set for this study. For example, if you estimated primate densities in the dry season, when less fruits might be available (and monkeys probably raid crops), and then repeat the survey in the same CF site in the wet season, a probable higher encounter rate might not mean that the hunting pressure has been reduced. That's why you record some ancillary information during the monitoring such as weather data and basic phenological data, as these additional data will help you to interpret the results. Hence the important point to remember is to report the conditions of your study (in the Methods section) and to report your results only in relation to those conditions.

4.0 ADD-ONS AND ALTERATIONS OF THE PROTOCOL

4.1 DISTANCE SAMPLING

Distance Sampling (BUCKLAND ET AL. 2001) is the same as Line Transect Sampling, but in addition to just recording the presence of animal signs, requires the exact distance measurements of the signs in relation to the transect line. If accurately recorded, the data will allow for calculating population densities of selected animal species, by using the computer program DISTANCE (THOMAS ET AL. 2009). Not all animal signs of the protocol, however, can be used for this analysis, but only direct observations, dung and chimpanzee nests. The method further requires a minimum number of 60-80 observations/species. If appropriate data are available, Distance Sampling could generate, for example, population estimates of chimpanzees, other monkey species and elephants, which might be of interest at particular CF sites. However, the data collection is more complex than outlined for the basic protocol, and the data analysis will require an expert / somebody who is familiar with the DISTANCE program. Hence it is not recommended to include Distance Sampling in the (bi-)annual monitoring, but it could be carried out for example every 5 years, given the required expertise for data analysis is available. The Distance data collection could be combined with the customary biomonitoring surveys and executed by the Field Assistant. It means that the Field Team would carry out the usual data recording along the transects as explained in section 3.5, accompanied by the Field Assistant who fills a separate data sheet as explained below.

A few principles need to be understood before going more into details. As mentioned above, two main factors limit the applicability of DISTANCE, (i) the type of sign, and (ii) the required minimum sample size of 60-80 observations per survey (a survey refers to one monitoring cycle of all transects per one CF site). Direct observations (that means that the respective animal species is seen) don't require any further ancillary information and can be analysed directly by DISTANCE, given the minimum sample size is available. If an animal species however is rare or very difficult to see, it is unlikely that a sufficient number of observations will be available to allow the calculation of its population density. This refers especially to small CF sites with a comparatively low number of transect lines. For example, the Sayee CF site might have 5-10 lines of 500m, which corresponds to a total survey length of 2.5 – 5 km, which makes it very unlikely to obtain sufficient direct observations of one species per monitoring cycle.

In case of indirect signs such as dung and chimpanzee nests, one will need additional information on the production and decay rate of these signs. For example, if during one monitoring cycle in the Kortor Forest one finds 45 chimpanzee nests, it does not automatically mean that there are at least 45 chimpanzees in the forest, as some nests might have been built by the same individuals. The same with dung – if one finds for example elephant dung along one transect and five days later along another transect it theoretically could have been produced by the same individual. Hence the need for the individual production and decay rates, which are not easy to get. They would either require additional studies, which most often are not feasible, or references from the literature have to be taken. These are mainly available for chimpanzee nests and elephant dung, while information on other species, for example on duiker dung

production and decay rates, is scarce or lacking. Distance Sampling in general is most commonly applied for primate and elephant censuses. These factors need to be carefully considered when deciding if a CF site is suitable for, and which species should be included in the Distance Sampling protocol.

The following explanations generally refer to all direct observations, all dung and chimpanzee nests. Two aspects need particular attention when filling the data sheet:

1. For DISTANCE it is crucial to distinguish between a *single observation* and a *clustered observation*. A single observation refers to one individual, for example one sees one Bay Duiker or finds dung of one elephant. However, some animals like chimpanzees, monkeys and elephants live in groups, so it is very likely that at a certain spot one finds not only signs of one individual but of more individuals of the same species. This is called a clustered observation. For example if you find a chimpanzee nest, it is very likely that there are more in the vicinity. In the data sheet, this will be indicated by the "No." as explained below.

2. Accurate distance measurement is vital and the linchpin for the data analysis. Distance Sampling requires the **perpendicular distance**, which is the shortest distance between the transect line and the sign (see Figure 16). For better illustration the right part of Figure 16 shows the difference between the perpendicular distance ("d", = the upper, straight short line) and the radial distance (the lower, longer diagonal line). Both measurements express the distance of the Zebra Duiker to the transect line, but the perpendicular distance is shorter than the radial distance. The angle between the perpendicular distance line and the transect line is always 90º.

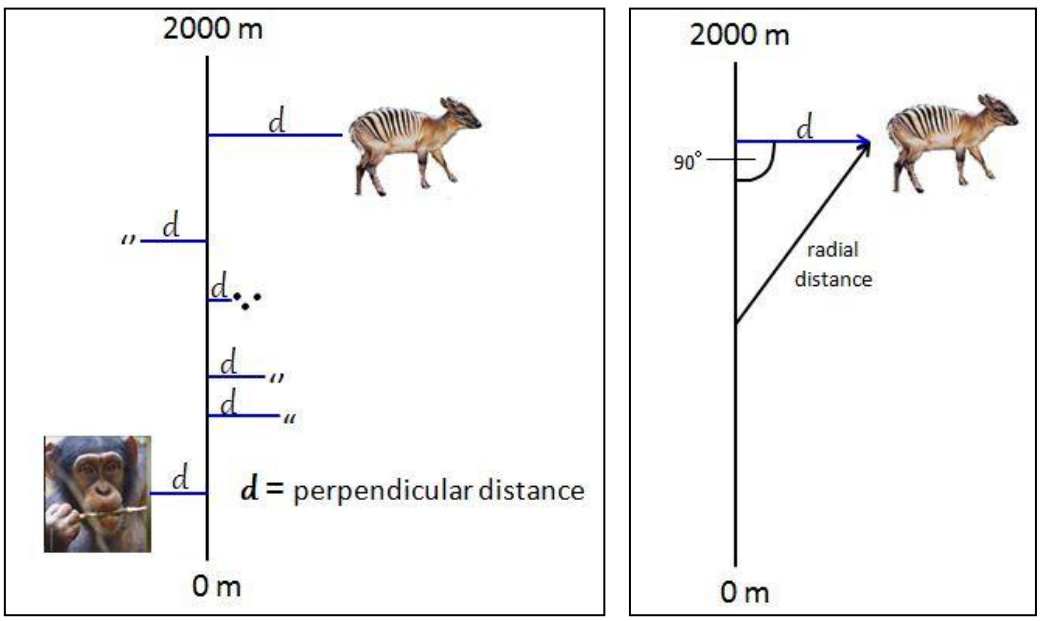


Fig. 16. Principle of Distance Sampling and the perpendicular distance

The perpendicular distances have to be measured accurately, and not just estimated. Use a tape measure and/or a rangefinder. It is further important that measurements of signs close to the line are made precisely. A common error of inexperienced observers is to record all distances nearby the transect (e.g. within 50 cm) as 0 m. This is wrong and can have a very strong negative impact on the accuracy of density estimates. More details will be outlined in the respective section below.

The Distance Sampling data sheet is attached in Annex 2D. Figure 17 shows an example section to illustrate the explanations.

CF Site: DISTANCE SAMPLING DATA SHEET Data Recorder:

Date:	Transect No:	Start Point:	Start Time:	End Time:

Fill this sheet for all direct encounters, dung and chimpanzee nests.
In case of clustered observations fill one row for each individual, but give all the same No.

No.	Time	Meter	Species	Type of sign	Distance (m, cm)	Age of sign	Group size	Remarks

Fig. 17. Example section of the data collection sheet

4.1.1 EXPLANATION

Headlines

CF Site:

Self-explanatory (for example Sayee CF)

Data Recorder:

Name of person who is measuring and filling the data sheet

Date:

Self-explanatory (Day/Month/Year)

Transect No.:

Self-explanatory (for example T04)

Start Point:

0m or 2000m (in case transect length is 2 km)

Start Time:

The time when you start the survey at the start point

End Time:

The time when you reach the end point and the survey is finished

Columns

No.:

Every observation will get a number. Observation refers to species level; start with 1 and then continue with 2, 3, 4, 5,…… etc. Other than in the basic protocol however, which does not further specify clustered observations, in this data sheet all individuals of a clustered observation will be listed separately, i.e. one row per individual, **where distance measurement is possible** (see below). To indicate that they all belong to the same observation, all will receive the same number **No.**. For example, along your transect you first see a Maxwell's Duiker, and later you find 3 chimpanzee nests, which obviously belonged to one group, next you will find Bay Duiker dung of

one individual and the fourth observation along the transect is dung of 5 elephants etc. The numbering would be as shown in Figure 26 further down. The individual listing is important because in Distance Sampling we are interested in the distance of the signs, and the more data sets, the better. If for example you encounter a group of three chimpanzee nests, they most probably will be at different locations and thus at different distances from the transect line. Hence the individual listing is indicated in all cases you can do accurate counts of individuals and measurements, which will mainly be the case for indirect signs (as they are stationary), and for direct encounters of single individuals (since even if the animal moves you can remember where you first saw it and take the measurement to that point). In case of group encounters, e.g. a group of monkeys, however, it most of the time will not be possible to count all individuals, not to speak of accurate measurements, as the animals will move. And again, since precise data recording is vital for DISTANCE, these data must not be estimated. So in case of group encounters, observers are advised to identify the (hypothetical) center of the group and record only one distance, i.e. the perpendicular distance from the line to the group center (see also explanation of measurements further below). Hence, for (uncountable) group encounters, there will also be only one record in the data sheet (see Figure 26, observations No. 5 and 6).

Time:

Note the time of your observation (hour:minutes).

Meter:

Note where on the transect line you are. Use the number of the nearest 50m mark. For example if you find some tracks at 1,790m, your nearest mark would be 1,800m.

Species:

Animal species, fill in the English name (see faunal indicator list Annex 3)

Type of sign:

It can only be either see, dung or nest. Use the following abbreviations:

- **SEE** for see;
- **DUN** for dung; and
- **NES** for chimpanzee nests

Distance (m, cm):

Perpendicular distance of an animal, dung or chimpanzee nest from the transect line. The perpendicular distances have to be measured accurately, by using a tape measure or, for larger distances or in case of inaccessible areas, by a range finder. Use the metric system and record them in meter and centimeter.

4.1.2 GENERAL NOTES ON THE MEASUREMENTS

- All measurements must be recorded as exact as possible. If you use the tape measure, the distance should be recorded to the nearest centimeter (e.g. 45 cm, 1.58 m; 8.65 m etc.). If you use the range finder, the distance must be recorded exactly as shown on the display.
- Perpendicular distances are measured from the **center** of the transect line. Sight along the transect and estimate where the center line lies. Imagine it as a very thin line indicating the exact center of the cut passage.

- Next identify the point on this imaginary center line from which the **perpendicular** distance should be measured. It might be necessary that you first will have to move along your transect line in order to reach the position from where you can measure the perpendicular distance. To find this point stretch out your arms and move along the transect line until your arms point exactly in a straight line towards the sign.

4.1.3 MEASUREMENT OF DIRECT OBSERVATIONS (SEE)

- If you see an animal, remember the place where you saw it first, because it might run away. You then measure the perpendicular distance from the transect line to the place where you saw it first (Figure 18). It might be necessary that you first will have to move along your transect line in order to reach the position from where you can measure the perpendicular distance.

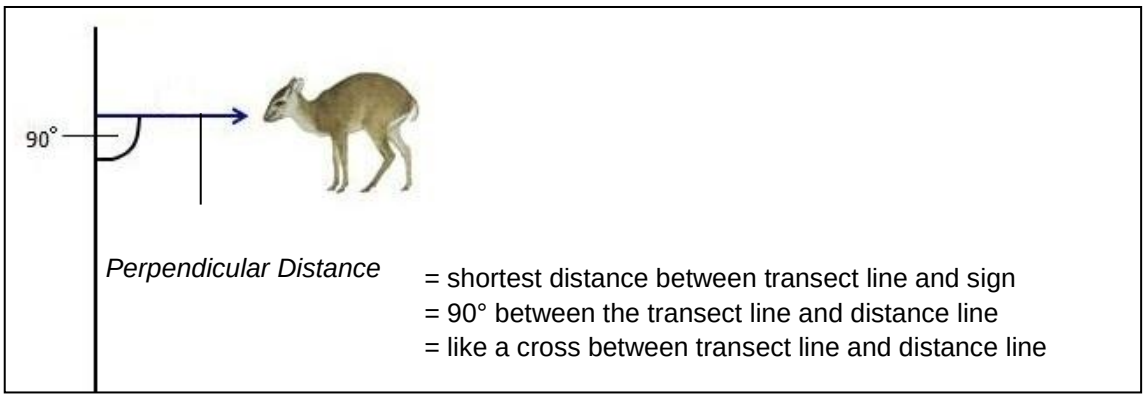


Fig. 18. Example for measurement of direct observations

- It is also important that the measurement is leveled and not inclined or slanting. It means that if you use the tape measure you will measure the distance on the ground level, and if you use the range finder you will measure the distance on eye level (see Figure 19). If the animal sits on a high tree then you have to imagine a straight line from its position to the ground and measure the distance to this imaginary line.

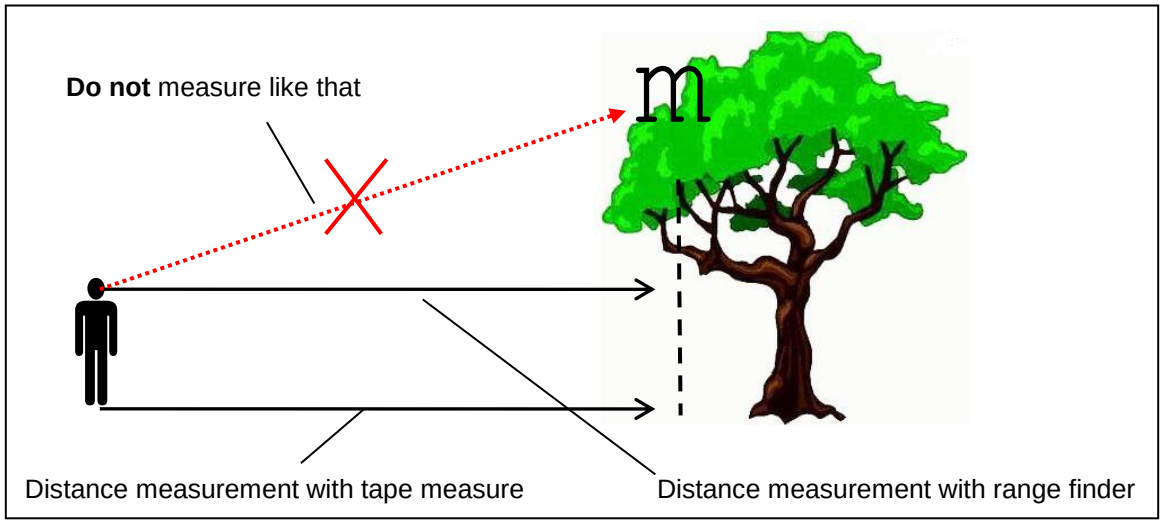


Fig. 19. Example for measurement of direct observations higher than eye-level

- If you see more than one individual, for example a group of elephants, then you have to determine the **imaginary center of the group** and measure the perpendicular distance to this imaginary center point (see Figure 20).

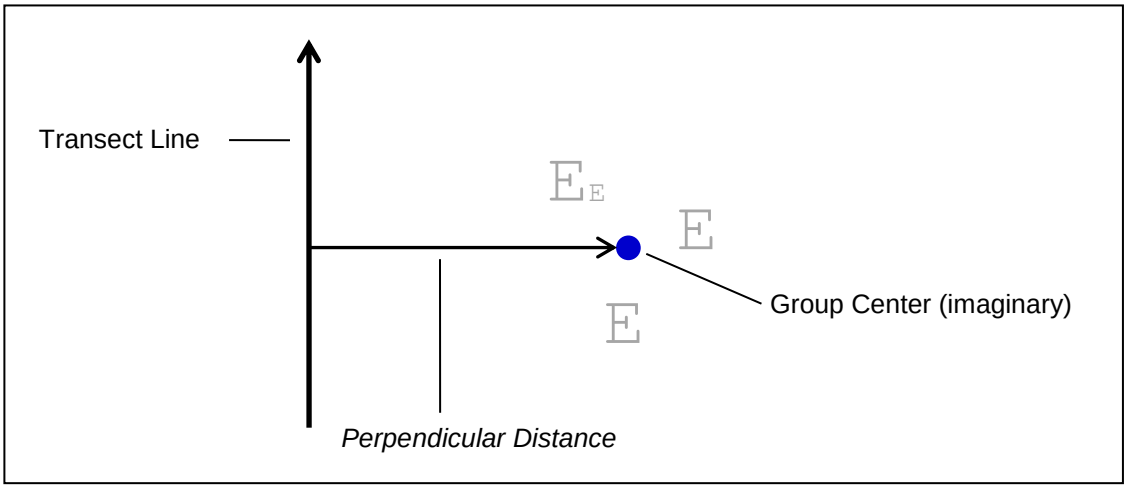


Fig. 20. Example for measurement if a group of animals is encountered

4.1.4 MEASUREMENT OF DUNG (DUN)

There are three main cases you will encounter when you have to measure the distance of dung:

a. The dung pellets (of 1 individual) form one cluster (Figure 21). Take the perpendicular measurement from the transect line to the <u>center</u> of this cluster:

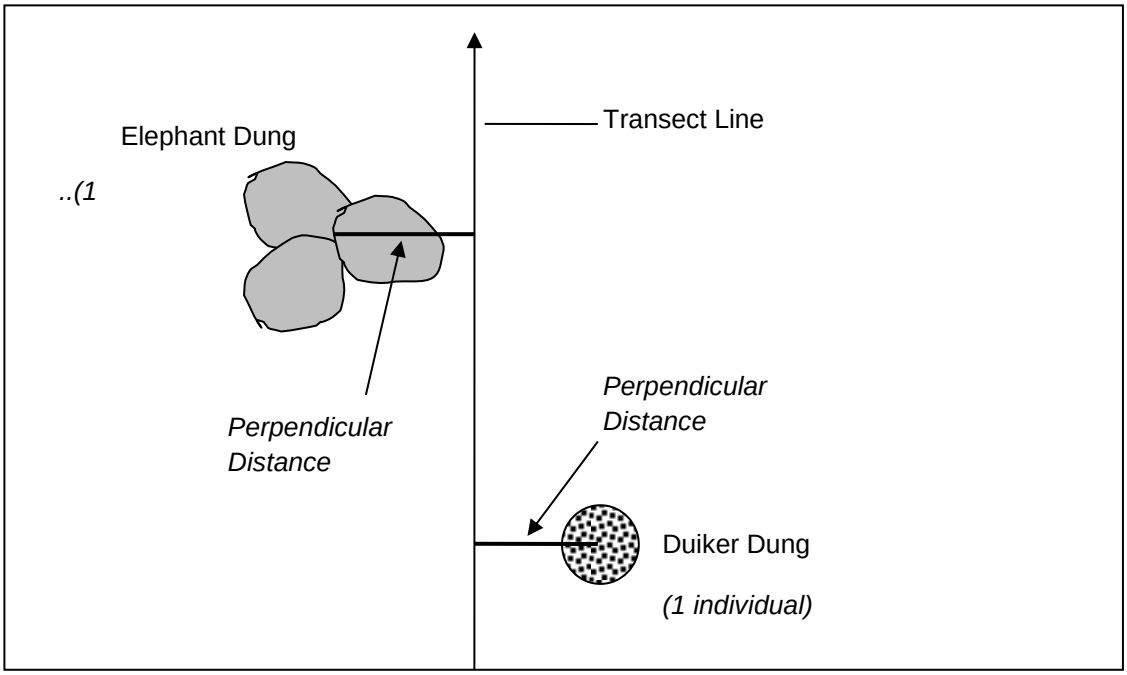


Fig. 21. Example for measurement of dung, which forms one cluster

b. The dung (of 1 individual) is dispersed (Figure 22). This might for example be the case for elephant dung. Elephants often defecate whilst moving, so the single boli (= dung balls) might be spread over several meters. Search carefully in order to make sure that you find all balls. Then take the measurement of the edges of the nearest (d1) and furthest boli (d2), add both distances and divide the sum by 2. The result is the perpendicular distance, which you have to enter in your data sheet.

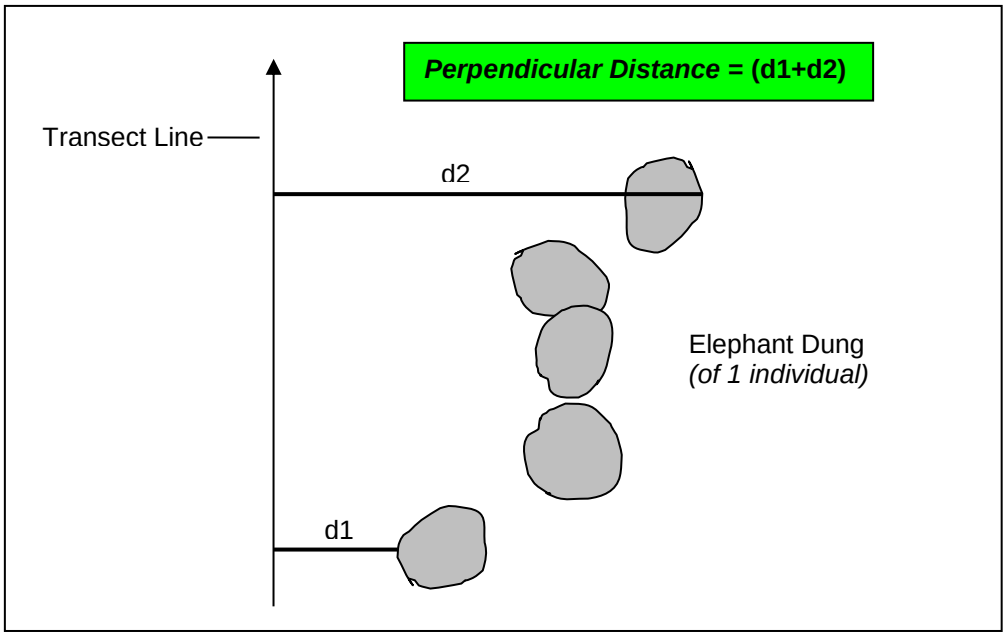


Fig. 22. Example for measurement of dung (of 1 individual), which is dispersed on one side of the transect line

An easier way to ascertain the perpendicular distance without calculation is to draw an imaginary box around the outermost boundary of the whole dung spot and determine the center point, which is the intersection of the diagonals (Figure 23):

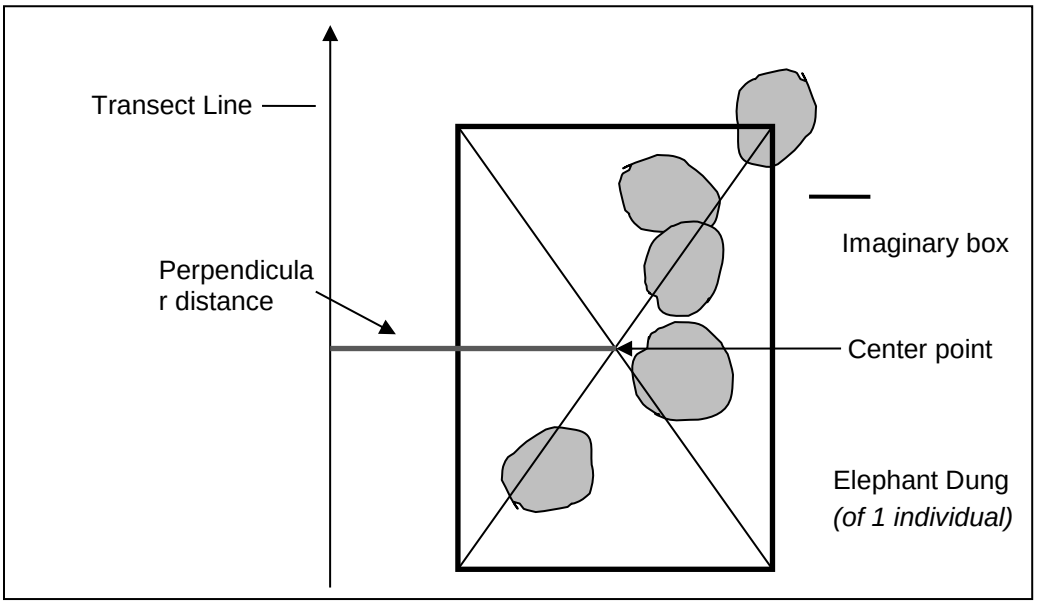


Fig. 23. Example for measurement of the perpendicular distance to the center point of an imaginary box around the dung balls

c. The dung (of 1 individual) is dispersed across **both** sides of the transect (Figure 24). In this case you have to measure the furthest edges on both sides of the transect (d1 and d2), subtract the smaller value from the larger value (in this example d2-d1) and divide the difference by 2. The result is the perpendicular distance you have to enter in your data sheet. An easier way is to draw an imaginary box and determine the center point as illustrated in Figure 23 above.

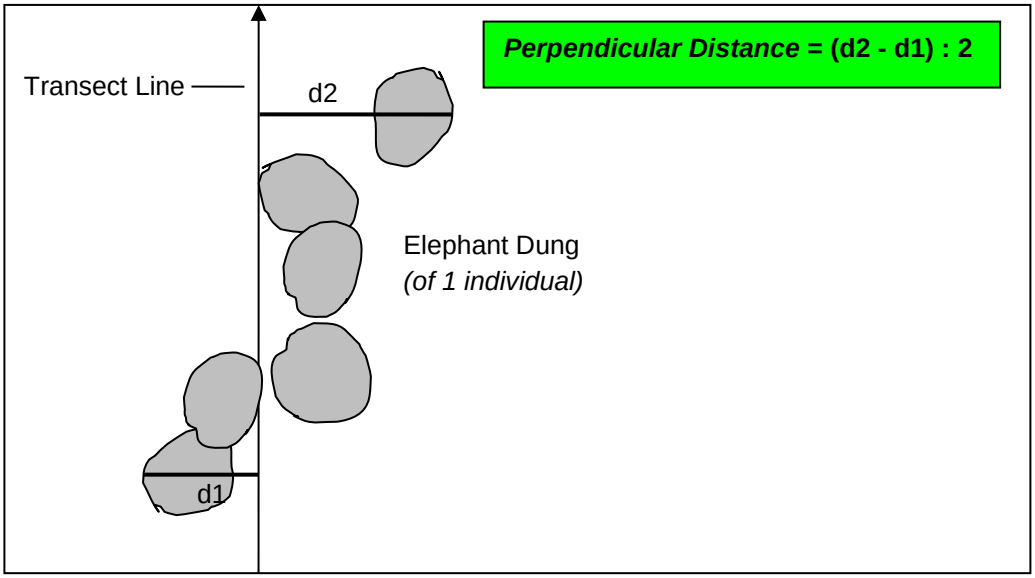


Fig. 24. Example for measurement of dung (of 1 individual), which is dispersed across the transect line

In case you have dung of **more than one** individual, repeat the measurement as explained for all individuals separately, and fill one row per individual.

4.1.5 MEASUREMENT OF CHIMPANZEE NESTS (NES)

Chimpanzees usually build their nests in trees. As already explained it is important to take a leveled (straight) measurement and not an inclined one (as indicated by the dotted line in Figure 25). The perpendicular distance of one nest is measured to the position on the ground that is directly under the center of the nest (see Figure 25).

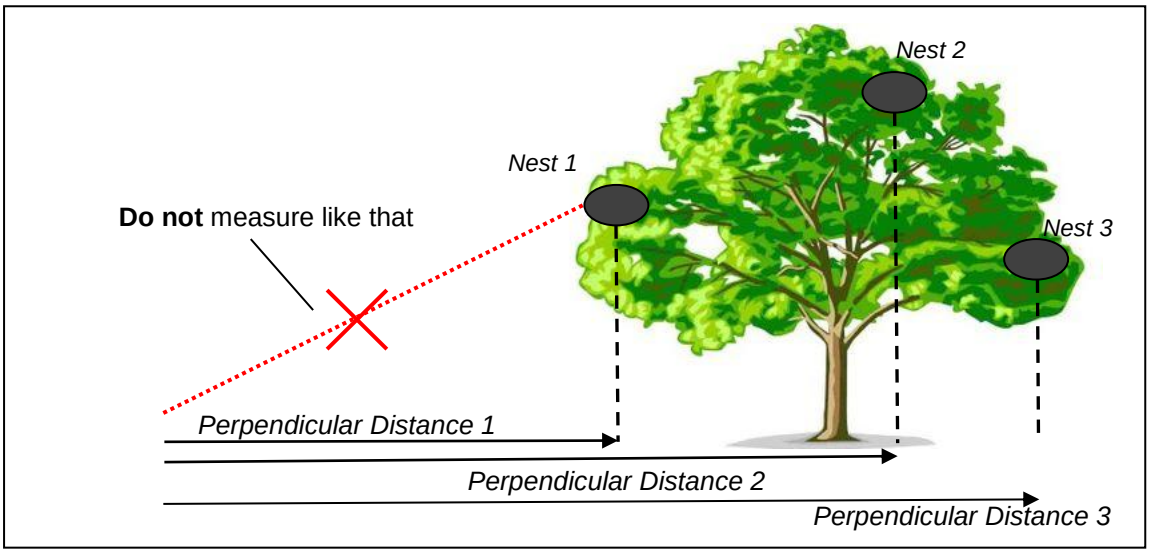


Fig. 25. Example for measurement of a cluster of chimpanzee nests.

As chimpanzee live in groups, usually if you find one nest, there will be more. It is important that you find **all** nests of the group, so in this special case it is allowed to leave the transect line and search for the other nests. Measure the distance of every single nest and fill one row per nest in the data sheet.

Age of sign:

Determine the age of dung and nests, by using one of the four age classes as explained in section 3.5, Table 1. **Do not** classify them without carefully reading the definition and then using the correct classification. This is essential, because there are international standards, especially in the case of elephant dung and chimpanzee nests. It is important to use the same codes to make sure that data are comparable with data from other biomonitoring programs.

Group size:

If you have a clustered observation, enter the total number of individuals. For example, if you encounter three chimpanzee nests, in each row of the individual nests you enter "3" in the "Group size" column. If you encounter dung of 5 elephants, enter "5" in the respective cells. This serves, mainly for indirect signs, as cross-check if you have recorded <u>all</u> individuals, since the number of individual rows of one clustered observation must correspond to the number you enter in the "Group size" column.

In case you encounter a group of monkeys, you might not be able to count them all, so enter the minimum number you could count. In case of single observations enter "1".

Remarks:

Here you will record any important notes you need to add to your observation.

Figure 26 shows an example of how to fill the data recording sheet for the following scenario (compare also with the example in section 3.5, Figure 11, to understand the main differences between the basic protocol and the Distance Sampling):

- On the 28th of March 2014, the Field Team together with the Field Assistant Mary Prosper carry out the biomonitoring data collection along Transect No. 14 in the Kortor CF. Mary is responsible for the Distance Data recording.
- They start the survey from the starting point at 07:52.
- At 08:18, at approximately the 150m mark, they see a Maxwell Duiker on the left side of the transect. The animal immediately runs away, but the Team and Mary remember where it stood. They measure a perpendicular distance of 4.65 meter.
- At 10:15 they encounter a fresh chimpanzee nest, at a distance of 1.48m off the transect line. Under the nest they find some dung of age class 2, so Mary makes a note on that in the "Remarks" column. They carefully check the surrounding area and discover two more nests, one directly above the transect line (which corresponds to a distance of 0.00m), also age class 1, and another one of age class 2 at a perpendicular distance of 3.78 meter. Since the three nests are very close together, they very likely were built by chimpanzees of the same group and hence they form a cluster. Thus the three records receive all the same observation number, No. 2, and the group size is 3.
- At 11:08 they find Bay Duiker dung, age class 3, at a distance of 1.22 meter. The observation was made not far from the 600m mark.
- The next observation, which is recorded in the Distance Data Sheet, is elephant dung between the 800m and 850m mark, at 11:44. The Team carefully checks the area and – also based on other indications such as tracks and roads – concludes that a group of elephants has roamed in that area, and identifies dung of five different individuals (at distances of 0.45m, 0.88m, 2.34m, 1.79m and 3.04m, respectively). The age class of the different piles was rated either 2 or 3. As in the case of the chimpanzee nests, this is a clustered observation, and each individual receives the same No. 4 (as it is the fourth observation along the transect).
- At 13:27, around 1,150 meter transect length, Mary and the Team see a group of Diana Monkeys, mixed with Red Colobus Monkeys. Since these are two different species and thus two different observations, they do not get the same, but separate observations numbers (No. 5 and No. 6, respectively). The Red Colobus Monkeys immediately flee as the field team appears, so they quickly have to decide where the group center point was at the initial contact. The same applies for the Diana Monkeys. The perpendicular distances were measured with a range finder at 14.70m, and 18.90m, respectively. The field team could count at least 7 Diana Monkeys, and 5 Red Colobus Monkeys.
- etc.

CF Site: Kortor CF | DISTANCE SAMPLING DATA SHEET | Data Recorder: Mary Prosper

Date: 28/03/2014	Transect No: T14	Start Point: 0m	Start Time: 07:52	End Time:

Fill this sheet for all direct encounters, dung and chimpanzee nests.
In case of clustered observations fill one row for each individual, but give all the same No.

No.	Time	Meter	Species	Type of sign	Distance (m. cm)	Age of sign	Group size	Remarks
1	08:18	150	Maxwell's Duiker	SEE	4.65	-	1	
2	10:15	550	Chimpanzee	NES	1.48	1	3	dung of age class 2 below the nest
2	10:15	550	Chimpanzee	NES	0.00	1	3	
2	10:15	550	Chimpanzee	NES	3.78	2	3	
3	11:08	600	Bay Duiker	DUN	1.22	3	1	
4	11:44	800	Elephant	DUN	0.45	3	5	
4	11:44	800	Elephant	DUN	0.88	3	5	
4	11:44	800	Elephant	DUN	2.34	2	5	
4	11:44	800	Elephant	DUN	1.79	3	5	
4	11:44	800	Elephant	DUN	3.04	2	5	
5	13:27	1150	Diana Monkey	SEE	14.70	-	7	
6	13:27	1150	Red Colobus Monkey	SEE	18.90	-	5	flee when they see us

Fig. 26. Example of how to fill the Distance Sampling data sheet.

4.2 BOTANICAL MONITORING

With more than 2,000 vascular plant species present in African rainforests, a selection has to be made which species should be monitored for what reason. As for the fauna, there are, for example, particular floral indicator species which can tell us something about the forest type and condition. Further, in a community forest commercialized harvesting of certain timber and non-timber species such as medicinal plants, food supplements etc. might be an issue and needs to be monitored. This chapter will outline some examples of botanical monitoring which might be relevant in the PROSPER's CF context. It has to be kept in mind, however, that botanical monitoring might require certain expertise, especially when it comes to identification skills. Since it would go beyond the scope of this handbook to go into elaborate details of the presented approaches, methods will be described more in generally and the interested reader is referred to relevant further readings for details.

4.2.1 GENERAL BACKGROUND

A common method for botanical assessments is to establish permanent sampling plots for regular monitoring. The plots can have any shape, for example be square, rectangular (strips) or circular. Since there is already a transect system in place, it is recommended to use these units at the same time as botanical sampling plots. The appropriate plot size will depend on the monitoring objectives and target species. If the focus lies on small-scaled plants such as Terrestrial Herbaceous Vegetation (THV), lianas or small-sized trees, a strip width of 1 meter on each side of the cleared transect line might be chosen (resulting in a total plot area of 0.40 ha (2 m x 2000m)), while for larger trees 2.5 meter on each side might be suitable (resulting in a plot size of 1 ha). In order to reduce "edge effects" - that means to decide whether objects located on the plot boundaries have to be included in the sample or not, and which evidently applies for larger trees in long narrow plots -, square plots (e.g. 50x50m) instead of strips might be established (more details on plot shape and size see for example WHITE AND EDWARDS 2000, p. 141). A plot's boundary must be accurately located, - particularly in case of square plots -, using a compass, tape measure and marking the corners (e.g. by painting trees as explained for the habitat description in section 3.3, or by planting stakes with coloured ribbons). For narrow strips a simpler method will be sufficient, for example use a hand-made device (a stick of the appropriate length or a string with knots tied at fixed length intervals) to measure the distance between the transect line and objects. It might neither be feasible nor desired to establish and monitor plots along all transect lines in a given CF site, so the basic biomonitoring protocol should include the botanical target species to inform on their spatial distribution and relative abundance, and hence help to decide where to establish the permanent sampling

plots. As with the transects, the botanical sampling plots should be numbered or identified by a distinct name, for example BSP01,...BSP14 etc. (it is recommended to use the same number as its corresponding transect line). Once the plot has been established, all "study objects" within the plot must be numbered, marked and listed. These might be either certain focus species (e.g. commercially harvested timber species) or all trees of a certain size (e.g. with a minimum stem diameter-at-breast-height (dbh) of 10 cm), depending on the monitoring objective. Use paint for marking, or label trees with a numbered tag. Use aluminum or galvanised nails if possible (these are less likely to rust and allow rot to enter the trunk). The plot list should contain general information such as plot number, date, tree number, species, the distance from the transect line in case of strips, the size (dbh) etc. As mentioned above the dbh refers to the stem diameter-at-breast-height (at 1.3 m), a standard way of measuring and reporting tree size, but actually one will not measure the stem diameter but the stem circumference and divide it by π (3.1416). In other words, a dbh of 10 cm corresponds to a circumference of approximately 30 cm. There are certain factors and special cases that need to be considered when measuring dbh, for details refer for example to WHITE AND EDWARDS 2000 (p. 131) or TEAM 2009 (p. 30).

The sampling plots can be used for example for the following studies.

4.2.2 INDICATOR SPECIES

Since certain tree species will grow to maturity only under specific conditions (e.g. waterlogged soil, light gaps, rock outcrops, river galleries, in villages) the presence of a mature tree of those species can "indicate" the actual or past condition of the forest. Since further the life span of some indicator species can be estimated, and trees generally are affected most strongly by environmental conditions during their initial growing period (i.e. seedlings and saplings), the presence of certain species in the forest can be used to estimate how long ago the forest was cleared, flooded, burned, etc.. For example, *Musanga cecropioides* and *Fagara macrophylla* are both shade-intolerant species, and thus indicate that light once reached the forest floor, and therefore that the canopy was disturbed. *M. cecropioides* will die before it is 25-30 years old, whereas *F. macrophylla* can live to be 100 years old. Therefore, the presence of *F. macrophylla* and the absence of *M. cecropioides* may indicate that some form of disturbance occurred between 25 and 100 years ago. This 75 year range might be narrowed further by looking at the number and condition of the *F. macrophylla* trees, and the estimated ages of other species growing nearby. Different species can be used to indicate various past events or environmental conditions. For example, the presence of domestic oil palms (*Elaeis guineensis*) in a tall, closed canopy forest is a good sign that people once used that land for farming. Table 4.1 lists a few indicator species, their estimated life spans, and what conditions they can be used to indicate (WHITE AND EDWARDS 2000).

The presence of these species in the CF site could be easily assessed by including them in the focus species list of the basic biomonitoring protocol along the transects, and wouldn't necessarily require the establishment of plots. If the Field Teams encounter a particular species along the transect they should record it in the "Species" column and give some ancillary data such as distance from the line and size in the "Remarks" column. This will, however, require firm identification skills of the locals and thus most probably additional training by a botanist.

TABLE 4.1. SELECTED BOTANICAL INDICATOR SPECIES OF WEST AFRICAN FORESTS AND THE TYPE OF INITIAL GROWING CONDITION THEY INDICATE

Species	Estimated Life Span	Condition Indicated
Musanga cecropioides	<25 yrs.	Disturbance
Macaranga spp.	15-20 yrs.	Disturbance
Anthocleista spp.	~ 20 yrs.	Disturbance
Trema guineensis	~ 20 yrs.	Disturbance
Fagara macrophylla	100 yrs.	Disturbance / Light gap
Ricinodendron heudelotii	100 yrs.	Disturbance / Light gap

Species	Estimated Life Span	Condition Indicated
Alstonia boonei	100 yrs.	Disturbance / Light gap
Hallea (*Mitragyna*) spp.	na	Wet or flooded ground
Nauclea pobeguinii / vanderguchtii	na	Wet or flooded ground
Macaranga schweinfurthii	na	Wet or flooded ground
Anthocleista vogelii	na	Wet or flooded ground
Raffia spp.	na	Wet or flooded ground
Guibourtia demeusii	na	Seasonally flooded areas
Uapaca spp.	na	Seasonally flooded areas
Domestic palms, bananas, mangoes etc.	na	Agriculture / old village

4.2.3 PHENOLOGICAL MONITORING

In case there is a special interest in the fruiting, flowering and leaf production patterns of certain trees or plants, the transects and/or plots can be used for phenological monitoring. The focus objects need to be marked, numbered and measured (dbh), entered in a list, and then re-visited for data collection regularly, usually once a month, and for a period of at least one year. The phenological study should comprise at least 5-10 mature individuals per tree/plant species to obtain meaningful results (if fruiting is of particular interest be sure to select female trees for dioecious species – species with male and female plants).

The monthly records might include:

- Young leaves, mature leaves, old leaves
- Flower buds, flowers in full bloom
- ripe and unripe fruit, both in the tree and on the ground

Estimating the quantity of leaves, flowers or fruits found on each tree is challenging, particularly if observers will be people with relatively little research experience. A relatively simple way to record estimated quantities is to use for example a three-point scale (see Table 4.2). Binoculars should be used to observe the canopy. The following indications help to identify the age of parts:

- *New leaves are smaller than mature leaves and of a light green or reddish colour*
- *Old leaves are either yellow or brown and shriveled*
- *Unripe fruits are often of a green colour*
- *Ripe fruits are bigger than unripe fruits and <u>might</u> have a distinct (red, yellow) colour and smell*

TABLE 4.2. EXAMPLE OF THREE-POINT SCALE FOR PHENOLOGICAL DATA COLLECTION

Part	0	1	2
Young leaves	none	few or limited to 1-2 branches	numerous over most of canopy
Mature leaves	none to very few	up to 75% of canopy	> 75% of canopy
Old leaves	none	few or limited to 1-2 branches	numerous over most of canopy
Flower buds	none	few or limited to 1-2 branches	numerous over most of canopy
Flowers	none	few or limited to 1-2 branches	numerous over most of canopy
Fruits on the tree	none	few or limited to 1-2 branches	numerous over most of canopy
Fruits on the ground	none	few	many and under most of crown

The advantage of a simple system such as this one is that data quality can be maintained even if many different observers are involved in data collection. The disadvantage is that the resolution is poor, and subtle changes may be overlooked. If the study of phenology patterns is deemed important and well

trained staff are available to collect the data, a more detailed methodology can be used (further reading see for example WHITE AND EDWARDS 2000, p. 149).

A less time-consuming variation of the "on-tree phenology" is the so-called "fruit-fall phenology", which measures only fruits that have fallen to the ground, and allows to determine seasonal fruiting patterns without too much effort. The fruit fall method however has the limitation that once fruit falls from the canopy it can be removed from the transect by animals. Still, fruit fall data have been shown to give comparable results to "on-tree" measures of fruit abundance in African forests (TUTIN AND WHITE 1998). Fruit fall phenology can be undertaken along the transects lines (given that the focus species are present along the transects). The transects are walked on a monthly basis and all fresh ripe and unripe fruits (of a particular species) fallen on a 1-meter strip are counted. Remove all fruits which could conceivably remain intact until the next census.

4.2.4 GROWTH, RECRUITMENT AND MORTALITY RATES

The botanical plots can also be used to monitor life cycles of for example trees and lianas. Regular sampling, e.g. once a year, over time will produce important data on mortality and growth rates, and give you an idea about the dynamics or turnover of the forest in your CF site. This information is essential specifically in view of a sustainable management of commercially harvested species.

After the initial establishment of the sampling plot as described above in the section "*General background*", all listed focus specimen will be re-visited regularly (e.g. annually), their dbh re-measured and the reason for any mortalities noted if apparent. New recruits, which were too small to be included in the sample on previous repeats should be added to the list, identified, measured and tagged. Accurate measurements are crucial to obtain reliable data, and more challenging than one might think, as practically there are a lot of special cases that need to be considered, for example such as the monitoring of lianas. The interested reader therefore is advised to consult further relevant literature (e.g. DALLMEIER ET AL. 1992; WHITE AND EDWARDS 2000; GERWING ET AL. 2006; TEAM 2009).

4.3 HARVESTING PRACTICES AND LEVELS

The biomonitoring protocol as introduced in section 3.5 follows a multiple approach including a variety of parameters, and intends to give a broad, comprehensive overview of the forest habitat's condition at different levels. Given this overall scope, it also has its limitations when it comes to more specific information on certain factors. This section provides some suggestions how best to monitor hunting practices and harvesting levels.

First of all, the monitoring protocol is flexible and allows adaptations. If there is a special interest in a particular plant or animal species, it should be included in the basic monitoring protocol. This will provide data on its abundance and spatial distribution, and thus, in case of plants for example inform where best to establish sampling plots (see previous section 4.2). Further the protocol offers, at least to some extent, room to specify information. If at a given CF site there is for instance the need to keep an eye on fishing practices, then fishing signs should be added as type of sign of human impact, and details given in the "Remarks" column. These could be the mesh size of fishing nets, baskets etc. If NTFP were harvested, the Field Team should be instructed to specify the harvesting method – was the whole plant cut down? In case of harvesting stranglers or climbers were the supporting trees injured? How large is the patch of bark cut from a tree? If hunters use different type of traps, classify them and indicate the type in the data collection sheet.

Due to the more or less random distribution of the transect lines, they might, however, not always include the parameters of interest, such as certain plant species or fishing areas, and the protocol certainly cannot replace more systematic in-depth studies, especially when it comes to quantifying data. In that case there is a need for additional research on the focus of interest, for example at the beginning of the project and

again after 3-5 years to evaluate any changes. Two main techniques - complemented by ancillary data of the basic biomonitoring protocol - are proposed to better understand and determine harvesting practices and levels: (1) well-structured personal interviews of a representative sample of the CF site's communities and, based on the information gathered through the interviews, (2) targeted field/forest surveys.

4.3.1 INTERVIEWS

The following information should be included in the questionnaire:

- Personal and socio-economic data of interviewee (age, sex, education level, main activity, main source of income, household size etc.)
- What kind of forest products are mostly harvested? (species and parts)
- Where are these products harvested?
- When / how frequently are these products harvested?
- How are the products harvested?
- Quantify the amount (for example how many animals are hunted in one week; how many bundles of thatch are cut in one day; how many bags of seeds are collected in one fruiting season etc.)
- Purpose (mainly for own consumption, or on a commercial level)
- Benefit / revenue in case of commercial purpose

4.3.2 FIELD SURVEYS

In addition to the interview-based information, supporting data should be collected directly "on site", i.e. the harvesting place. For example, a number of interviewees could be selected and monitored over a period of several weeks, and probably repeatedly at different times of the year where necessary (depending on the type of harvested resource). The data collector (e.g. the Field Assistant) will accompany the locals regularly, for instance once or twice a week, to the harvesting place and take notes on the type of harvested resource (species and parts), harvesting method, extracted amounts etc. Hunting camps in different areas should be visited at regular intervals (e.g. once a month), and ideally comprise multi-day surveys, during which the data collector would stay in the camp, monitor the daily catch (species, amounts) and accompany the hunters on stalks. In case of timber and NTFP collection, it is further recommended to regularly monitor botanical transects or plots where harvesting occurs and which contain the respective plant species, especially during harvesting periods. To assess the actual human impact on these resources, it is however necessary to compare these data with data from "untouched" control plots (that means plots in areas where harvesting is prohibited), which might be the limiting factor for the feasibility of this undertaking. This is important because the condition or status of forest resources is influenced by many factors, such as weather conditions, and resources are also consumed by animals. The control plots therefore must not only contain a comparable number of the target species, but also lie within the same forest type and be monitored at the same time as the plots affected by harvesting.

More detailed information on interview techniques, bushmeat surveys and NTFP collection is found for example in WHITE AND EDWARDS 2000; GREENGRASS 2011; MANVELL 2011; USAID 2011; AML AND CI 2012. The interested reader is also advised to consult the following homepage of the Center for International Forestry Research (CIFOR): http://www.cifor.org/pen/research-tools/the-pen-prototype-questionnaire.html.

5.0 TRAINING MODULES

5.1 GENERAL OVERVIEW

5.1.1 TARGET GROUP

The training introduced in this handbook focuses on the local communities at the CF sites. It should enable them to carry out the basic biomonitoring operations as introduced in sections 3.2, 3.3, 3.4 and 3.5. The training shall be carried out by the Program Coordinator, with assistance of the Field Assistants. Depending on the education level, there might be a need however to train the Program Coordinator and the Field Assistants as well. They will need a comprehensive understanding of the whole program, including contents, implementation, equipment etc. before starting to set-up the biomonitoring program. It is therefore recommended that a Technical Advisor of PROSPER is assigned to supervise the program throughout the PROSPER project period, to train the Program Coordinator and Field Assistants and step-by-step hand over the program to the Program Coordinator.

5.1.2 CONTENT AND METHODOLOGY

The Training will comprise 2 Modules with the following topics:

- Module 1:
  - Introduction to Biomonitoring
  - Weather data recording
  - Line Transect Sampling
  - Navigation in the forest (compass, GPS)
  - Habitat description
  - Optional: Logistics and planning of field trips; Ethics in the field
- Module 2:
  - First aid training by a certified person
  - Indicator species list and identification
  - Data recording methodology
  - Optional: Distance Sampling

Module 1 refers to the Implementation Steps 2-4 (see sections 3.2-3.4), and thus has to take place before Step 2; it will take 10-12 days. Module 2 needs to be carried out before Implementation Step 5 (see section 3.5) and will take approximately 8-10 days. Both Modules comprise a combination of theoretical, interactive lectures, simulation exercises at the workshop venue and practical exercises during one- or multi-day field trips. The learning by doing approach will play an important role. More details on the Modules are outlined in sections 5.2 and 5.3 below.

5.1.3 PARTICIPANTS

Prior to the workshop suitable participants from each community need to be selected. As mentioned in section 2.2, a field team per CF site should comprise 6 locals, amongst them some experienced hunters as well as some literate persons. It is however advisable to include more people in the training for general capacity building, and in case there will be a need for replacement of any team members later on. For logistical reasons it is also possible to carry out one training for several CF sites combined, but the maximum number of participants per Training Module should not be more than 20 persons. It further has to be kept in mind that the time gap between the training and the actual Implementation Steps should not be too long, otherwise a refresher training will be necessary again prior to implementation of the program. In the optimum case the implementation of the respective program steps per CF site should follow immediately after the training.

5.1.4 TRAINING MATERIALS

A comprehensive list of all required training materials is given in sections 5.2 and 5.3, as well as attached in Annex 1. The individual participants' stationeries should include a training manual (script, examples see Annex 4), a note book, pen, pencil, eraser, ruler, marker and clear bag. Further it would be nice and motivating to include a small personal gift, such as a cap, an illustrated field guide, a name tag, T-Shirt etc.

5.1.5 VENUE

The venue for the training should be carefully selected - for example in a central village which can be reached equally by participants from different areas - and within the village a remote area suited for learning - preferably a palaver hut or hall which is properly ventilated, light, has adequate seating capacity and access to bathrooms nearby.

5.1.6 OPENING/REGISTRATION

A formal Opening on the first training day will prelude the workshop and follow the usual agenda, i.e. commence with an opening prayer, followed by welcoming remarks of the trainer, self-introduction of all participants and a presentation of the overall objectives of the program by the trainer. Participants should also be encouraged to introduce their personal expectations of the training. All participants should be registered in a list by name, gender, age, village, profession, education level etc.. It is recommended to record the presence of participants on all of the following workshop days as well.

5.1.7 GROUND RULES

At the beginning of the training it is advisable to declare some regulations which should be followed by all participants to make sure things run smoothly throughout the workshop. Participants could come up with their own suggestions; for example include the following:

- *Be in time*
- *No sleeping*
- *Mobiles off or silent during lectures*
- *No smoking*
- *No absence without giving any reasons <u>before</u>*
- *Respect each other/everybody's questions etc.*

5.1.8 PRESENTATION

The way of presenting lecture contents is essential for the successful learning and motivation of the trainees. At some CF sites it might be necessary or recommendable to appoint a facilitator, especially if some of the participants mostly speak the local dialect and might not understand all in English. This could be either the Field Assistant or another focus person of the community such as the project's community mobilizers. The trainer must find a suitable way, depending on the auditorium, how best to communicate lessons and encourage interaction, active participation and questions. S/he should be open for and show interest in all participants' individual issues related to the course. Nothing is more boring than listening to a monologue without being actively involved in the happening. Complex topics should be explained by simple examples, preferably taken from the locals' real daily life rather than being very abstract (for example replace the term "perpendicular distance" by "shortest straight distance", explain "sustainability" based on bags of rice or cassava etc.). It is highly recommended to use well illustrated PowerPoint Presentations. Such visual aids will support the learning effect and also help illiterate persons to understand the main principles. Theoretical lessons should not take longer than 40 minutes without taking a break. The trainer should pay attention to decreasing levels of concentration and overall fatigue, and when necessary suggest short breaks and some physical exercises. Lectures during the hottest time of the day should be avoided, and people should also have some resting time immediately after a meal. Theoretical lessons should alternate with practical exercises whenever possible.

5.1.9 EVALUATION

The knowledge the trainees have acquired should be tested, either by the end of the workshop or on completion of each main topic. Before developing the test, the trainer needs to define the most important educational objectives that need to be evaluated and then select the most appropriate means. These could include for example questionnaires, multiple choice tests as well as practical tasks formulations (i.e. save waypoints by GPS, measure the distance of certain objects by the tape measure and range finder etc.). The textbox headline "Objectives" in section 5.2 and 5.3 will help to define the respective learning targets. The evaluation among others will enable the Program Coordinator to select the most suitable candidates for the field teams. At the end of each Training Module, all participants should receive a certificate stating that they have joined the training (probably rating their test results in words such as *outstanding*, *very successful*, *successful* etc., and no additional comment for the less successful trainees. Negative ratings should be avoided in the certificate.).

5.2 MODULE 1

The following agenda serves as guidance and will allow some flexibility, which is necessary for a successful workshop. It does not prescribe detailed durations of lectures, since this will depend on the education level, previous knowledge and questions of the auditorium. Instead the agenda gives a rough orientation of expected time frames by indicating morning and afternoon sessions. The morning session could for example be scheduled from 8:30 – 12:00, and the afternoon session from 13:30 – 16:30, but it is recommended to arrange the most suitable hours directly with the participants. Further, it is advisable to start every morning with a short re-cap of the previous day's topics and activities, especially when a new topic will be introduced (for the sake of overview this is not listed in the presented itinerary).

TABLE 5.1. PROPOSED AGENDA TRAINING MODULE 1

Day	Topic/Activity	Session
1	Opening	Morning
	Introduction to Biomonitoring	Morning + Afternoon
2	Weather Data Recording - Theory	Morning
	Weather Data Recording - Practice	Afternoon

Day	Topic/Activity	Session
3	Line Transect Sampling - Basic concept	Morning
	Navigation in the forest I: Use of map and compass - Theory	Morning + Afternoon
4	Navigation in the forest I: Use of map and compass - Practice	Morning
	Navigation in the forest II: Use of GPS - Theory	Afternoon
5	Navigation in the forest II: Use of GPS - Theory and Practice	Morning + Afternoon
6	Navigation in the forest II: Use of GPS - Practice	Morning
	Habitat description	Morning + Afternoon
	Prepare for test	Afternoon
7	BREAK / Prepare for test	Full day
8	Test	Morning
9+10	Establish a transect - Practice in the field	Morning + Afternoon
11	Discuss test results	Morning
	Logistics and planning of field trips	Afternoon
	Ethical behaviour in the field	Afternoon
	Workshop summary and closure	Afternoon
12	Plan and prepare field trip for establishing transects	Morning + Afternoon
from 13	Establish transects in the forest	

The agenda foresees starting the transect establishment immediately after the workshop, i.e. commencing from Day 13 onwards.

An exemplified Training Manual is attached in Annex 4A. It has been compiled based on relevant literature, e.g. WHITE AND EDWARDS 2000; BUCKLAND ET AL. 2001; TOWNSEND ET AL. 2008; PRIMACK 2010; AGREN AND ANDERSON 2012 etc., and contains the details of the training program in a simplified and illustrative way, both for the trainer and the trainees. However, contents can be modified and adjusted as needed. In the following, the key information for each training topic is summarized in text boxes.

Topic: Introduction to Biomonitoring
Content – Introduction of basic concepts and definition of key terminologies: *Fauna, Flora, Species, Endemic species, Fully protected species, Biodiversity, Ecosystem, Conservation Biology, Sustainability, Biodiversity Hotspot, Upper Guinean Rainforest, Importance of Liberia's forests, Biomonitoring*
Objectives – Trainees should understand the terms and be able to describe them and give examples – Trainees should be able to explain why Liberia, conservation, sustainable management of natural resources and biomonitoring are important
Guidance for interaction/practice/exercises – Before explaining terms, ask trainees if they have an idea of the meaning; let them find examples
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; field guides (to show pictures, for example of endemic species; e.g. Kingdon 2003; Borrow and Demey 2008)

Topic: Weather data recording
Content – Theoretical background: *Definition of weather and climate; influences of weather; type of weather parameters; recording and analysis of weather data* – Practice: *Set up weather station; record weather data; analyse weather data*
Objectives – Trainees should understand the importance of weather data and be able to record them correctly
Guidance for interaction/practice/exercises – Involve trainees in theory by asking questions before explaining terms and concepts – Hand out instruments and let trainees handle them to get familiar with – Fill rain gauge with varying amounts of water and let trainees do the recording – Set-up weather box together and let trainees record weather data every morning at 9 am during the course – Prepare a sheet with hypothetical data (e.g. for one month) and let trainees calculate average temperatures, humidity and total amount of rainfall; prepare a sheet with hypothetical monthly weather data for one year and let trainees draw the graph
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; weather box; weather instruments: digital thermo-hygrometer with min/max function and battery, rain gauge (respective quantities will depend on the number of workshop participants, it is recommendable to have more than one instrument (e.g. one thermometer and rain gauge for 5 persons) for practicing and as back-up); data sheets for exercises; weather data entry sheet; calculators; shovel and digging equipment; hammer; nails; handsaw

Topic: Line Transect Sampling
Content – Introduction of basic concepts and definition of key terminologies: *Sampling*, *Sampling designs and methods, Line Transect Sampling, Distance Sampling*
Objectives – Trainees should understand key terms and the importance of a good sampling design – Trainees should be able to list different sampling methods and describe them – Trainees should be able to explain why we will use Line Transect Sampling for the CF biomonitoring program – Trainees should be able to explain "encounter rate" and "total abundance" – Trainees should be able to explain the difference between basic Line Transect Sampling and Distance Sampling
Guidance for interaction/practice/exercises – Involve trainees in theory by asking questions before explaining terms and concepts – Make some practical exercises for better illustration of the "perpendicular" distance (e.g. draw a line with a stick on the ground and place some objects left and right off the line, ask trainees from where on the line to measure the perpendicular distance)
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners

Topic: Navigation in the forest
Content – Theory: *Introduction to the basic principles of orientation and navigation (cardinal points and ways how to determine them); basic concepts and use of a map, compass and GPS; how to establish a transect line by use of GPS and compass* – Practice: *Determine cardinal points; read a map; determine and find directions by compass; operate basic functions of the GPS (navigate to a waypoint, save a waypoint, correct data recording from the display); establish a straight line and navigate around an obstacle*
Objectives – Trainees understand and are able to explain basic principles of orientation (cardinal points; natural and technical aids for orientation etc.). – Trainees can read a map and determine the distance between locations on a map. – Trainees understand the concept of a compass and can use the compass to (1) determine direction of objects, (2) find a given direction, (3) cut a straight line and (4) navigate around an obstacle – Trainees understand the basic principles of a GPS (including the meaning of the coordinates and the UTM system) and can use the GPS to (1) navigate to a waypoint, (2) save a waypoint and (3) correctly record data from the GPS.
Guidance for interaction/practice/exercises – Involve trainees in theory by asking questions before explaining terms and concepts. – Repeat learning contents by asking questions (where does the sun rise/set; what do you do if you are lost in the forest etc.) – Practical exercises to determine North, East, West and South: e.g. (1) in class mark arbitrary positions on paper (flipchart) as North or any other direction and ask trainees for the location of the three other cardinal points; (2) outdoors: point into an arbitrary direction assumed to be North (or East etc.) and ask trainees for the location of the other cardinal points – Read a map: Let trainees explain a map (key features) and calculate distances between different locations on the map – Use of compass: (1) general handling (observe needle when turning around; stand still and turn the dial; observe what happens if compass is held leveled or inclined; observe what happens to the needle if metallic objects are brought close to the compass); (2) determine directions (start with North first - it is important that trainees understand the concept that the needle always points North); give trainees hypothetic bearings (in degrees, e.g. 240°; 130° etc.) and let them use the compass to find the correct direction of these bearings; (3) cut a straight line by using the compass; (4) navigate around an obstacle by compass – Use of GPS: (1) general handling (switch on, scroll through pages, zoom in and out, read coordinates); (2) navigate to waypoints (prepare GPS units before exercise, i.e. save some waypoints - for example conspicuous landmarks such as a huge tree, a well etc. -, and let trainees navigate to these waypoints and describe the landmarks for crosschecking); (3) save a waypoint; (4) record coordinates, elevation etc. from the display
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; different maps (including one of the respective CF site; further other maps for demonstration, e.g. a map of Liberia etc.); compasses (Recta DT 100; provide sufficient units for practice, e.g. one for three persons); GPS (Garmin map 62s, if budget allows also provide more units for practice); batteries for GPS; sheets of paper; cutlasses; files; 50m tape measure

Topic: Habitat description
Content – Theory: *Introduce key terminologies and features for habitat description (habitat, forest types, forest structure, topography); Explain why and how to mark and describe the transects* – Practice: *Fill habitat description sheet, for example along the line that was cut as exercise in the previous section (see Textbox "Navigation in the forest"); main practice will be done on Day 9 and 10 (see next Textbox "Establish a transect - Practice in the field")*
Objectives – Trainees are able to establish a transect and fill the habitat description sheet correctly
Guidance for interaction/practice/exercises – Involve trainees in theory by asking questions before explaining terms and concepts – Following theory let trainees fill a habitat description sheet
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; habitat description sheets; clipboards; paint and brushes; 50m tape measure; GPS

Establish a transect - Practice in the field
Content – On Day 9 and 10 of the workshop, trainees will establish one "real" transect line in the CF
Objectives – Trainees successfully establish and complete a straight transect line in the CF, including navigation to the starting point, marking and habitat description
Guidance for interaction/practice/exercises – How best to arrange will depend on the number of participants. There should not be more than 6 persons practicing at the same time on a line, otherwise it becomes boring for the rest. In case the group is bigger, it could be split in appropriate sized sub-groups, which either work alternating (successively) on the same line or each sub-group establishes its own line (but in the latter case note that the trainees need to be supervised and that the lines might be too far apart from each other, so that it will not be possible for the Program Coordinator and Field Assistants to supervise all teams equally) – Program the starting and ending point(s) into the GPS and let trainees navigate to the line
Materials – GPS, compass, cutlasses, files, 50m tape measure, paint and brushes, habitat description sheets (take some spare), clear bag, clipboard, pencils, eraser, sharpeners, backpacks, food, water

Topic: Logistics and planning of field trips
Content – General guidelines for effectively organizing biomonitoring field surveys
Objectives – Trainees, and especially the designated Team Leaders, are able to plan and organize a field trip
Guidance for interaction/practice/exercises – Trainees should be encouraged to come up with their own suggestions
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners

Topic: Ethical behaviour in the field
Content – General guidelines for team building and environmental awareness
Objectives – Trainees understand importance of considerate and respectful behaviour both for humans and nature, as well as for being successful at work
Guidance for interaction/practice/exercises – Involve trainees in theory by asking questions before explaining terms and concepts – Trainees should be encouraged to come up with their own suggestions
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners

5.3 MODULE 2

TABLE 5.2. PROPOSED AGENDA TRAINING MODULE 2

Day	Topic/Activity	Session
1	Opening	Morning
	First aid training	Morning + Afternoon
2	First aid training	Morning + Afternoon
3	Species list and identification	Morning
	Exercises: Species identification	Afternoon
4	Discussion of results of exercises	Morning
	Data recording methodology: General notes	Afternoon
	Revision Line Transect Sampling	Afternoon
5	Data recording methodology: Data Collection Sheet	Morning
	Data recording Exercise 1 (in class)	Afternoon
6	Data recording Exercise 2 (in the field)	Morning + Afternoon
7	BREAK	
8	Discussion of results of exercises	Morning
	Important rules for accurate data collection	Afternoon
	Workshop summary and closure (or continue)	Afternoon
9	Optional add-on: Distance Sampling - Overview	Morning
	Distance Sampling - Data Collection Sheet	Morning + Afternoon
	Practice: Use of tape measure and range finder	Afternoon
10	Exercises Distance Sampling	Morning
	Discussion of results of exercises	Afternoon
	Workshop summary and closure	Afternoon

An exemplified Training Manual is attached in Annex 4B; contents can be modified and adjusted as needed. In the following, the key information for each training topic is summarized in text boxes.

First Aid Training
Content – The First Aid Training should be conducted by a certified med person and adjusted to the specific needs of field work (e.g. focus on the specific situation of people being in the field for several days, probably without communication; focus on emergencies that could happen during field work, e.g. sprains, fractures, cuts and gashes, snake bites, malaria attacks, etc.)
Objectives – Trainees should be able to handle basic emergency cases – Trainees should have a basic understanding of commonly used drugs (analgesics, antibiotics etc.) and be able to use them in a responsible and correct way
Guidance for interaction/practice/exercises – Practical demonstration exercises of first aid measures together with trainees
Materials – First aid books (at least one per Field Team), which could also be carried along on field surveys (e.g. Werner et al. 1994; Auerbach 2003); Probably the trainer, together with the Program Coordinator and Field Assistants, could prepare and provide some basic training materials (summary of most important topics); participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); flipchart stand and paper; markers; sharpeners; mats for practical training; First Aid Kit (one per Field Team)

Topic: Species list and identification
Content – Definition and explanation of key terminologies: *indicator species, threatened species, IUCN, phenology, human impact.* Introduce proposed faunal species list for monitoring; test and practice identification skills
Objectives – Trainees should understand key terms and be able to describe them and give examples – Trainees should understand the importance of correct species identification
Guidance for interaction/practice/exercises Involve trainees in theory by asking questions before explaining terms and concepts – Use pictures of animals for better illustration (e.g. for threatened animals; animal species of faunal indicator list) – Go through the faunal indicator species list and note the local names in an extra column – Species identification skills test/exercises (e.g. use PowerPoint presentations and let trainees note the answers on paper): (1) Show trainees pictures of animals native to Liberia, mixed with alien species (e.g. lion, bears etc.) and ask trainees to note the species and names of those which occur in Liberia; (2) Show trainees pairs of similar species, one of them native to Liberia and the other one not (e.g. Leopard and Cheetah; Campbell's Monkey and Mona Monkey; Bay Duiker and Ader's Duiker etc.; alternate the numbers, i.e. let the Liberian species not always be the first of the pair shown) and ask them which one of the two is found in Liberia; (3) Present trainees different signs of the indicator species (e.g. footprints, dung, vocalisation) and let them identify the species
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; field guides (e.g. Kingdon 2003; Borrow and Demey 2008); pictorial charts; test sheets; paper

Topic: Data recording methodology
Content – Theory: *Introduce the general guidelines for biomonitoring implementation; Introduce and explain the Data Collection Sheet; Optional: Revise main principles of Line Transect Sampling as introduced in Module 1 if necessary* – Practice: *Data recording exercises, Fill data collection sheet*
Objectives – Trainees should understand the procedure and practical implementation of biomonitoring operations – Trainees should understand the terms and meaning of all data types they will have to record along the transects, and be able to fill the Data Collection Sheet correctly
Guidance for interaction/practice/exercises – Weather data: after explaining let trainees go outdoors and determine the actual weather condition by using the introduced scale – Insert additional examples of the correct numbering of observations to make sure everybody understands the concept – Show numerous examples (pictures) for the different age classes of the different signs. It is very important that trainees understand that the 4 classes are defined depending on the type of sign! – Data recording exercises: (1) Prepare a sheet of paper with a hypothetic scenario, similar to the one given in the Training Manual (at the end of section 2.2) and let trainees fill the data collection sheet accordingly; (2) set-up a simulation transect line around the workshop venue (e.g. mark a straight line on the ground with a stick and place "signs" along the line, use for example pictures of animals, goat dung and footprints, fruits and seeds etc.) and let trainees fill the data collection sheet; (3) let trainees carry out data collection along one of the real CF transects
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; data collection sheets; materials for exercises; clipboards; watches; cutlasses; files; laminated field manuals (e.g. species list in English and local dialect; table with age class classification etc.); food and water for field trip; (GPS in case there is a need to navigate to the transect)

Topic: Important rules for accurate data collection
Content – General guidelines for correct data collection to minimize risk of recording mistakes
Objectives – Trainees should understand the importance of correct data collection – Trainees should be aware of typical pitfalls and be able to list common measures to avoid them
Guidance for interaction/practice/exercises – Involve trainees and let them explain why and how to avoid typical recording mistakes – Involve outdoor practice, e.g. simulate transect lines hitting mountable and insurmountable obstacles (e.g. hitting a tree or termite mounds) etc. – Together with the trainees make a good survey plan for biomonitoring operations per CF site
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; map of transect system/CF site; calendar

Optional: Distance Sampling
Content – Theory: *Introduce the basic principles of Distance Sampling and key terminologies (single and clustered observations, perpendicular distance etc.); Introduce the metric system; Introduce and explain the Distance Data Collection Sheet; Introduce the basic concept of a range finder* – Practice: *General handling of the range finder; accurate measurement both by tape measure and range finder; fill data collection sheet*
Objectives – Trainees understand and are able to explain basic principles and key terms of Distance Sampling – Trainees understand and are able to explain the difference between basic Line Transect Sampling and Distance Sampling – Trainees can correctly read and use the tape measure and range finder – Trainees understand the terms and meaning of all data types of the Distance Data Collection Sheet – Trainees are able to fill the Distance Data Collection Sheet correctly
Guidance for interaction/practice/exercises – Involve trainees in theory by asking questions before explaining terms and concepts. – Support the understanding of the "perpendicular distance" by practical examples on the paper and outdoors – Explain the metric system with illustrations (a ruler, size of common objects, distances etc.) – Practical exercises how to use and read the tape measure – Use of range finder: (1) general handling (switch on/off, switch from meter to yard and vice-versa, check reflecting features of different objects (a white wall, a tree stem, a car etc.)); (2) measure distances of different objects – Exercises to fill Distance Data Collection Sheet: (1) in class: Prepare a sheet of paper with a hypothetic scenario, similar to the one given in the Training Manual (at the end of section 3.2) and let trainees fill the data collection sheet accordingly; (2) set-up a simulation transect line around the workshop venue (e.g. mark a straight line on the ground with a stick and place "signs" along the line, use for example pictures of animals, goat dung and footprints, fruits and seeds etc.) and let trainees fill the data collection sheet; (3) let trainees carry out data collection along one of the real CF transects
Materials – Participants' stationeries (training manual, note book, pen, pencil, eraser, ruler, marker); PowerPoint presentation; projector; screen (or use a white wall); flipchart stand and paper; markers; sharpeners; 50m tape measure; Range Finder (Nikon Laser 550; if budget allows provide more units for training purposes); batteries for range finder; Distance data collection sheets; exercise sheets; materials for simulated line transect exercise; clipboards; watches; cutlasses; files; laminated field manuals (e.g. species list in English and local dialect; table with age class classification etc.); food and water for field trip; (GPS in case there is a need to navigate to the transect)

REFERENCES

AGREN GI AND ANDERSSON FO (2012). Terrestrial Ecosystem Ecology. Principles and Applications. Cambridge, Cambridge University Press; UK.

ARCELORMITTAL LIBERIA LIMITED (AML) AND CONSERVATION INTERNATIONAL (CI) (2012). Further Ecological Studies as part of the Environmental and Social Impact Assessment for ArcelorMittal Liberia: Bushmeat and Biomonitoring studies in the Northern Nimba Conservation Area. AML 2012.

AUERBACH PS (2003). Medicine for the Outdoors. 4th edition. Lyons Press, Guilford, USA.

BORROW N AND DEMEY R (2008). Birds of Western Africa. A and C Black Publishers Ltd., London.

BUCKLAND ST, ANDERSON DR, BURNHAM KP, LAAKE JL, BORCHERS DL AND THOMAS L (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford: Oxford University Press.

CONSERVATION INTERNATIONAL (2001). From the Forest to the Sea: Biodiversity Connections From Guinea to Togo. Conservation Priority-Setting Workshop, December 1999. Washington DC.

DALLMEIER F, KABEL M AND RICE R (1992). Methods for long-term biodiversity inventory plots in protected tropical forest. MAB Digest Series 11. UNESCO, Paris.

GERWING JJ, SCHNITZER SA, BURNHAM RJ, BONGERS R, CHAVE J, DEWALT SJ, EWANGO CEN, FOSTER R, KENFACK DM, MARINEZ-RAMOS M, PARREN M, PARTHASARATHY N, PÉREZ-SALICRUP DR, PUTZ FE AND THOMAS DW (2006). A Standard Protocol for Liana Censuses. Biotropica 38(2): 256–261.

GREENGRASS E (2011). Exploring the dynamics of bushmeat hunting and trade in Sapo National Park. FFI internal document, Cambridge, UK.

IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2. http://www.iucnredlist.org.

KINGDON J (2003). The Kingdon Field Guide to African Mammals. London: A and C Publishers Ltd.

KÜHL H, MAISELS F, ANCRENAZ M AND WILLIAMSON EA (2008). Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations. Gland, Switzerland: IUCN SSC Primate Specialist Group.

MAISELS F AND ABA'A R (2011). Survey design (Section 3). In: IUCN SGA Monitoring – Great ape survey book. Web edition. http://apes.eva.mpg.de/eng/pdf/guidelines/IUCN_SGA_Monitoring_Section_3_Survey_design_For_web.pdf

MANVELL A (2011). Use of Non-Timber Forest Products around Sapo National Park, Liberia. FFI internal document, Cambridge, UK.

PRIMACK RB (2010). Essentials of Conservation Biology. 5th edition. Sinauer Associates, Massachusetts, USA.

TEAM NETWORK (2009). Vegetation Protocol Implementation Manual, v. 1.5. Tropical Ecology, Assessment and Monitoring Network, Center for Applied Biodiversity Science, Conservation International, Arlington, VA, USA.

THOMAS L, LAAKE JL, REXSTAD E, STRINDBERG S, MARQUES FFC, BUCKLAND ST, BORCHERS DL, ANDERSON DR, BURNHAM KP, BURT ML, HEDLEY SL, POLLARD JH, BISHOP JRB AND MARQUES TA (2009). Distance 6. 0. Release 2. . Research Unit for Wildlife Population Assessment, University of St. Andrews, St. Andrews, UK.

TOWNSEND CR, BEGON M AND HARPER JL (2008). Essentials of Ecology. 3rd edition. Blackwell Publishing, Oxford, UK.

TUTIN CEG AND WHITE LJT (1998). Primates, phenology and frugivory: Present, past and future patterns in the Lopé Reserve, Gabon. In D. M. Newbery, H.H.T. Prins and Brown N. *Dynamics of populations and Communities in the Tropics*. Blackwell Science Ltd. Oxford. pp. 309-338.

USAID (2011). Land Rights and Community Forestry Program (LRCFP). Conservation International Final Report. Internal project document, November 2011.

USAID (2012a). PROSPER. Final Site Assessment Report. Internal project document, August 2012.

USAID (2012b). PROSPER. Biodiversity Assessment Report. Internal project document, November 2012.

USAID (2012c). PROSPER Gender Strategy. Internal project document, July 2012.

VOGT M (2011). Results of Sapo National Park Bio-Monitoring Programme 2007-2009. FFI internal document, Cambridge, UK.

WAITKUWAIT WE AND SUTER J (2003). Report on the first year of operation of a community-based bio-monitoring programme in and around Sapo National Park, Sinoe County, Liberia. FFI internal document, Cambridge, UK.

WERNER D, CARY F, THUMAN C, MAXWELL J AND PEARSON A (1994). Where there is no doctor: Village Health Care Book for Africa. 2nd edition, Macmillan Education, Oxford, UK.

WHITE L AND EDWARDS A (eds.) (2000). Conservation research in the African rain forests: a technical handbook. Wildlife Conservation Society, New York, USA.

ANNEX 1: LIST OF EQUIPMENT

The following table lists the equipment required for the implementation of the biomonitoring program; the x indicates which items are needed for which step. Given quantities serve as guidance, but will actually depend on the number of field teams, field team members, and trainees.

Item	Quantity	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Module 1	Module 2
Laptop	1	x					x	x	x	x
Color Printer	1							x	x	x
Laminator	1								x	x
Projector	1								x	x
Screen	1								x	x
Maps of CF/transect system	several	x	x			x		x	x	x
Flipchart stand	1								x	x
Stationeries (paper, note books, markers, pens, pencils, ruler, eraser, sharpener, stapler, scissors, clipboards, calculators etc.)	continuously as needed							x	x	x
Training Manuals Module 1 and 2	1 each per trainee								x	x
Data Sheets	continuously			x	x	x			x	x
Field guides (e.g. Kingdon 2003; Borrow and Demey 2008)	1 each								x	x
First aid books (e.g. Werner et al. 1994; Auerbach 2003)	1 per team					x				x
First Aid Kit	1 per team					x				x
GPS Garmin map 62s	1 per team	x	x	x		x			x	x
Compass Recta DT 100	3 per team		x						x	
Range Finder Nikon Laser 550	1 per team									x
Binoculars	2 per team					x				
Camera	1 per team					x				
Cutlasses	4 per team		x			x			x	x
Files	4 per team		x			x			x	x
Tape measure 50m	1 per team		x	x					x	x
Color paint for marking trees	as needed		x	x					x	
Brushes for painting	4 per team		x	x					x	
Umbrellas	1 per team					x				
Tarpaulins	per team 2 big (5x5m) for the sleeping tent and 1 small (3x3m) as kitchen tent					x				
Ropes for fixing tarpaulins etc.	several					x				
Cooking pots	2 per team					x				

Item	Quantity	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Module 1	Module 2
Buckets	1 per team					x				
Dishpan	1 per team					x				
Cooking spoons	2 per team					x				
Plates	1 per trainee					x			x	x
Spoons	1 per trainee					x			x	x
Cups	1 per trainee					x			x	x
Sleeping pad	1 per team member					x				
Sleeping bag	1 per team member					x				
Army backpack 40 ltr	1 per team member					x			x	x
Flashlights	1 per team member					x				
Whistle	1 per team member					x				
Watch	1 per team					x				
Uniform	1 per team member					x				
Raincoat	1 per team member					x				
Rainboots	1 per team member					x				
Weatherbox	1 per CF site				x				x	
ThermoHygrometer	1 per CF site				x				x	
Rain Gauge	1 per CF site				x				x	
Batteries (GPS, cameras, range finder, flashlights, thermometer etc.)	continuously		x	x	x	x			x	x
Boxes / cabinets to store equipment at CF sites or field offices	1-2 per CF site	throughout program								

PROPOSED ISSUANCE SCHEME (GENERAL GUIDANCE)

Frequency	Item
Every 5 years	GPS, range finder, camera, binoculars, cooking pots and spoons, dishpan, backpack, sleeping bag, sleeping pad, plate, spoon, cup
Every 2 years	50m tape measure, tarpaulins, bucket, watch, uniform
Yearly	Cutlasses, files, umbrella, raincoat, rainboots, whistle, flashlights

ANNEX 2: DATA COLLECTION SHEETS

ANNEX 2A: HABITAT DESCRIPTION FORM

Habitat Description - Transect No.:

Transect No.: **Date:** **Team:** **Cutting direction:**

	Forest Structure						**Topography**		**Water resources**	**Notes**
Meter	Type	Tree species	Tree height	Lianas	Canopy cover %	Ground cover %	Level	Elev.		
0										GPS Data
50										
100										
150										
200										
250										
300										
350										
400										
450										
500										
550										
600										
650										
700										
750										
800										
850										
900										
950										
1000										

1050										
1100										
1150										
1200										
1250										
1300										
1350										
1400										
1450										
1500										
1550										
1600										
1650										
1700										
1750										
1800										
1850										
1900										
1950										
2000										GPS Data

Forest Type: **PF** Primary Forest/Old Secondary; **YS** Young Secondary; **FB** Farmbush; **TH** Thatch

Tree species: **Mix** Mixed; **Dom** Dominant (mention dominant tree species in the "**Notes**" column)

Tree height: **20**; **25; 30**; **35; 40 etc.** (estimate the average height (m) of the highest trees)

Lianas: **0** none; **1** few; **2** medium; **3** many

Canopy cover %: **0; 25; 50; 75; 100** (as percentage of the sky that is covered by canopy)

Ground cover %: **0; 25; 50; 75; 100** (as perc. of ground that is covered by ground vegetation)

Level: **LL** Lowland; **S** Slope (↑ uphill;↓ downhill); **R** Ridge

Elevation: in meters, read from GPS

Water: describe if swamp or creeks etc. nearby transect

Notes: describe special features, e.g. treefalls, camps etc.

ANNEX 2B: WEATHER DATA RECORDING SHEET

Location:			Month/Year:		
Date	Humidity %		Temperature ° C		Rainfall mm
	max	min	max	min	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

ANNEX 2C: BIOMONITORING DATA COLLECTION SHEET

CF Site: BIOMONITORING DATA COLLECTION SHEET Month/Year:

Date:	**Start Point:**
Transect No:	**Start Time:**
Team:	**End Time:**
Data Recorder:	**Number of sheets:**

Weather data - take records every hour

use one of the following numbers for clouds, rain and wind: 0, 1, 2 or 3 (0=none, 1=small, 2=medium, 3=heavy)

Time:										
Clouds:										
Rain:										
Wind:										

No.	Time	Meter	Species	Type of sign	Number ind / nests	Age of sign	Remarks

ANNEX 2D: DISTANCE SAMPLING DATA SHEET

CF Site: DISTANCE SAMPLING DATA SHEET Data Recorder:

Date:	Transect No:	Start Point:	Start Time:	End Time:

Fill this sheet for all direct encounters, dung and chimpanzee nests.
In case of clustered observations fill one row for each individual, but give all the same No.

No.	Time	Meter	Species	Type of sign	Distance (m, cm)	Age of sign	Group size	Remarks

ANNEX 3: FAUNAL INDICATOR SPECIES LIST

The following list serves as a general guideline for the species, which should be included in the biomonitoring program. The list however might need to be adjusted to site-specific criteria and priorities, by, for example, discarding some species which don't occur at the site and/or adding other species (including plants) of interest.

No.	English name	Scientific name	IUCN status[1]
1	Chimpanzee	*Pan troglodytes verus*	EN
2	Black-and-White Colobus	*Colobus polykomos*	VU
3	Olive Colobus	*Procolobus verus*	NT
4	Red Colobus	*Procolobus badius badius*	EN
5	Campbell's Monkey	*Cercopithecus campbelli*	LC
6	Diana Monkey	*Cercopithecus diana diana*	VU
7	Spot-nosed Monkey	*Cercopithecus petaurista*	LC
8	Sooty Mangabey	*Cercocebus atys atys*	NT
9	Elephant	*Loxodonta africana cyclotis*	VU
10	Pygmy Hippopotamus	*Choeropsis liberiensis*	EN
11	Leopard	*Panthera pardus*	NT
12	Golden Cat	*Caracal aurata*	NT
13	Bongo	*Tragelaphus eurycerus*	NT
14	Buffalo	*Syncerus caffer nanus*	LC
15	Bushbuck	*Tragelaphus scriptus*	LC
16	Jentink's Duiker	*Cephalophus jentinki*	EN
17	Yellow-backed Duiker	*Cephalophus silvicultor*	LC
18	Zebra Duiker	*Cephalophus zebra*	VU
19	Maxwell's Duiker	*Philantomba maxwellii*	LC
20	Black Duiker	*Cephalophus niger*	LC
21	Bay Duiker	*Cephalophus dorsalis*	LC
22	Ogilby's Duiker	*Cephalophus ogilbyi brookei*	VU
23	Royal Antelope	*Neotragus pygmaeus*	LC
24	Water Chevrotain	*Hyemoschus aquaticus*	LC
25	Red River Hog	*Potamochoerus porcus*	LC
26	Giant Forest Hog	*Hylochoerus meinertzhageni*	LC
27	Giant Pangolin	*Smutsia gigantea*	NT
28	Long-tailed Pangolin	*Uromanis tetradactyla*	LC
29	Tree Pangolin	*Phataginus tricuspis*	NT
30	Black-casqued Hornbill	*Ceratogymna atrata*	LC
31	Yellow-casqued Hornbill	*Ceratogymna elata*	NT
32	White-crested Hornbill	*Tropicranus albocristatus*	LC
33	Brown-cheeked Hornbill	*Bycanistes cylindricus*	NT
34	African Pied Hornbill	*Tockus semifasciatus*	LC
35	Piping Hornbill	*Bycanistes fistulator*	LC
36	White-breasted Guineafowl	*Agelastes meleagrides*	VU
37	Great Blue Turaco	*Corythaeola cristata*	LC

No.	English name	Scientific name	IUCN status[1]
38	Dwarf Crocodile	*Osteolaemus tetraspis*	VU
39	Slender-snouted Crocodile	*Mecistops cataphractus*	DD
	etc		

[1] IUCN Red List (2012). Classifications: EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data Deficient

ANNEX 4: TRAINING MANUALS

ANNEX 4A: TRAINING MANUAL MODULE 1

PROSPER

PEOPLE, RULES AND ORGANIZATIONS SUPPORTING THE PROTECTION OF ECOSYSTEM RESOURCES

BIOMONITORING HANDBOOK FOR COMMUNITY FORESTRY IN LIBERIA

ANNEX 4 A

TRAINING MANUAL MODULE 1

CONTENT

1. Introduction to Biomonitoring……..…….1

2. Weather data recording…….6

3. Line Transect Sampling…….……9

4. Navigation in the forest……..…..15

5. Habitat description……... 36

6. Logistics and planning of field trips……40

7. Ethical behaviour in the field…….……..42

1 Introduction to Biomonitoring

This chapter will introduce you to some basic principles which are important to know and understand for the biomonitoring program. It will start with the definition of some commonly used terms.

Fauna

Fauna is the scientific term for all kind of animals (monkeys, duikers, pigs, chicken, insects, snails, fish, snakes, frogs, butterflies, spiders, crabs etc.).

Flora

Flora is the scientific term for all kind of plants (trees, scrub, lianas, flowers, grass, crops etc.).

Species

Species is a scientific term to define a group of individuals (of animals, plants or other living forms) with similar appearance, and which are capable to breed and produce fertile offspring (that means that the offspring will also breed and produce offspring etc.).

Examples: Human, Chimpanzee, Uapaca, Leopard, Bush Pepper, Forest Elephant, Goat, Bay Duiker……..find more!

Endemic species

An endemic species is a plant or animal species which can only be found in a particular region and nowhere else on our planet. Because of their limited distribution, endemic species are more vulnerable to threats and extinction than other, more common and widespread species.

Examples: ***Zebra Duiker*** is endemic to the Upper Guinean Rainforest
Nimba Otter Shrew is endemic to a small region in Liberia, Guinea and Côte d'Ivoire
Liberian Mongoose is only known from eastern Liberia and western Côte d'Ivoire

Fully protected animals

Certain animal species in Liberia, for example rare or endangered species, are fully protected under the Wildlife Laws of Liberia. Fully protected means that an animal species is prohibited from any killing, possessing or trading all over Liberia; hence this also applies to a community forest. The current list as issued by the Forestry Development Authority is attached at the end of this chapter, page 4ff.

Biodiversity

Biodiversity is the abbreviation of "Biological Diversity", and means the variety of all plants and animals and other organisms (life forms) on our planet, together with the places (habitats) where they are found.

The forests of ***Liberia*** for example are known to harbour more than 2,000 vascular plant species, approximately 125 terrestrial mammal species, 590 bird species, 74 known reptiles and amphibians and over 1,000 described insect species.

Ecosystem

An ecosystem is an interconnected and interacting system of living organisms (plants, animals and other) and the environment they live in and depend on. A typical ecosystem can be a forest, a swamp, a meadow, a coral reef, a river etc..

Conservation Biology

Protection of biodiversity and ecosystems from extinction or from severe damage by human activities.

Sustainable use of natural resources

Use of (limited) natural resources (e.g. water, land, forest, flora, fauna) in a prudent manner to ensure that they are not harvested beyond the natural replenishment capacity of the ecosystem. Sustainable use of a particular resource is at a rate that will not impair the ability of future generations to meet their needs. With other words: "***Eat some, keep some***!"

Biodiversity Hotspot

Regions on earth with high species richness, a great number of endemic species and that are / have been seriously impacted and threatened by human activities.

Upper Guinean Rainforest

The Upper Guinean Rainforest stretches from southern Guinea and eastern Sierra Leone eastward through Liberia, Côte d'Ivoire and Ghana into western Togo (see map). It is considered one of the world's most important Biodiversity Hotspots.

Remains of the Upper Guinean Rainforest (map of Liberia's Forest Re-Assessment Project 2002)

Liberia contains the largest proportion, with an estimated 42% of the remaining Upper Guinean Rainforest. Côte d'Ivoire is estimated to hold 28%, while Ghana, Guinea, Sierra Leone and Togo share the remaining 30%. A conservation priority-setting initiative for the Upper Guinean Forest Ecosystem in December 1999 identified Liberia as the top priority country in humid West Africa from a conservation perspective!

Biomonitoring

Biomonitoring means the regular and long-term observation of the status of living organisms, usually certain animal and plant species. In areas with human impact (such as hunting, logging, harvesting of forest products etc.), we usually also monitor the extent of human activities. Biomonitoring not only provides important knowledge on the biodiversity in a given area, but also helps to identify and monitor threats to the ecosystem, and therefore enables the managing authorities to take appropriate measures for a sustainable management of the resources.

Why is the conservation and sustainable use of natural resources important?

Natural resources are essential for the survival of humans. Our very lives depend on clean air and freshwater. Plants act as a natural air filter, taking in carbon dioxide and expelling oxygen, which people and animals breathe. Aside from filtering the air, many plants are food sources for humans and animals, and also used for medicinal purposes. Trees have another important function, as timber. Wood is a common building material, and numerous products contain wood. Animals also form part of the food chain for humans. Meat is an important component of many people's diets. Meat and dairy farmers rely on this resource as a source of income. Animals further help with various aspects of labor. Work animals are common in many parts of the world, especially in less industrialized nations, where mechanical equipment is lacking. Apart from these direct benefits do natural resources also have spiritual and cultural values, and are important for recreation and tourism.

So let's protect our forests!

Fully Protected Animals of Liberia

(Ref: Forestry Development Authority Liberia)

Fully protected species means any animal species prohibited from any killing or possessing under the Wildlife Laws of Liberia.
This list shall be modified whenever the Authority deems it necessary to reflect new information on the status of protected animals. Some of the species on the list are also on CITES list of endangered species.

Common Name	Scientific Name	Local Name
PRIMATES		
1. West African Chimpanzee	*Pan troglodytes verus*	Baboon
2. Black & white colobus	*Colobus polykomos*	King monkey
3. Red colobus	*Piliocolobus badius*	Red monkey
4. Olive colobus	*Procolobus verus*	
5. Diana monkey	*Cercopithecusdiana diana*	
6. Mona monkey	*Cercopithecus campbellii*	
7. Lesser spot-nosed monkey	*Cercopithecus petaurista*	
8. Sooty mangabey	*Cercocebus atys*	Jackal
9. Lesser galago	*Galago senegalensis senegalensis*	
PROBOSCIDEA		
1. Elephant	*Loxodonta africana cyclotis*	Elephant
ARTIODACTYLA		
1. Bongo	*Tragelaphus eurycerus*	Elk deer
2. Forest buffalo	*Syncerus caffer nanus*	Bush cow
3. Ogilby's duiker	*Cephalophus ogilbyi*	Black back
4. Jentink's duiker	*Cephalophus jentinki*	White antelope
5. Yellow-backed duiker	*Cephalophus silvicultor*	Yellow back
6. Zebra duiker	*Cephalophus zebra*	Marking deer
7. Royal antelope	*Neotragus pygmaeus*	Tricky jack
8. Water chevrotain	*Hyemoschus aquaticus*	Water deer
9. Red river hog	*Potamochoerus porcus*	Red hog
10.Giant forest hog	*Hylochoerus meinertzhageni*	Black hog
11.Pygmy hippopotamus	*Hexaprotodon liberiensis*	Water cow
CARNIVORA		
1. Leopard	*Panthera pardus*	Leopard
2. Liberian mongoose	*Liberiictis kuhni*	
3. Golden cat	*Felis aurata*	Bush cat
PHOLIDOTA		
1. Giant pangolin	*Smutsia gigantea*	Big ant bear
2. Long-tailed pangolin	*Uromanis tetradactyla*	Ant bear
3. Tree pangolin	*Phataginus tricuspis*	Ant bear

SIRENIA

1. West African Manatee	*Trichechus senegalensis*	Sea cow

REPTILES

Crocodilus

1. Nile crocodile	*Crocodylus niloticus*	Alligator
2. African slender-snouted crocodile	*Crocodylus cataphractus*	Alligator
3.African dwarf crocodile	*Osteolaemus tetraspis*	Crocodile

Squatama

1. Rock python	*Python sebae*	Boa constrictor
2. Ball python	*Python ragius*	Boa constrictor

Chelonia

1. Green sea turtle	*Chelonia mydas*	Green turtle
2. Loggerhead sea turtle	*Caretta caretta*	Sea turtle

BIRDS

Accipitridae (Osprey, Falcons, Buzzards, etc)

Falconidae (Kestrels, falcons, etc.)

All birds of prey

Bucerotidae

1. All hornbills

Musiphagidae

1. All turacos

Picathartidae

1. Bare-headed rockfowl
2. Grey-necked rockfowl
3. White necked rockfowl

Psittacidae

1. All parrots

Phasianidae

1. White-breasted Guineafowl	*Agelastes meleagrides*	Guineafowl

2 Weather data recording

Weather: State of the atmosphere (clouds, sunshine, temperature, rain etc.) at a given time & place

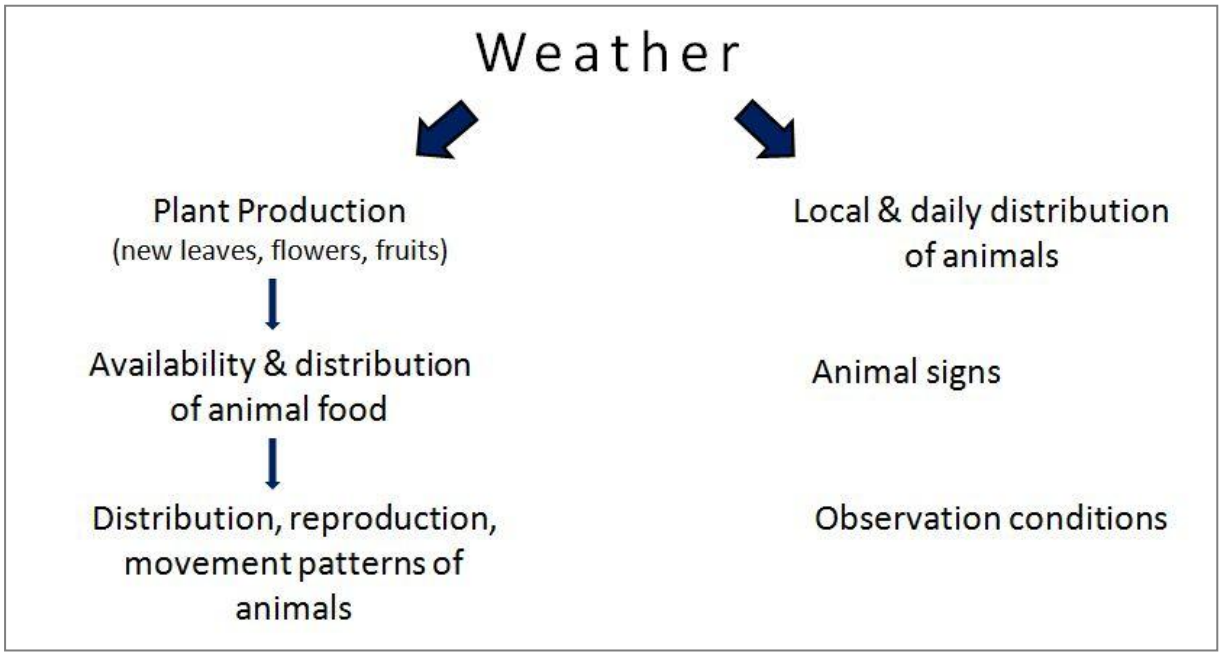
⇨ Day-by-day situation

Climate: Weather conditions over several ten years (at least 30 years)

⇨ Longterm situation

Why record weather data?

Influences of weather:



⇨ help us to understand the abundance, distribution, reproduction, activity and behaviour of animals

Types of weather data:

- Temperature
- Rainfall
- Humidity (water content in the air)
- Wind direction and wind speed
- Cloud cover
- Sunshine and solar radiation

Recording of weather data:

Weather data are recorded every day, always at the same time, usually at 9 am

Temperature
- is measured with a thermometer in ºC (*pronounce*: degree Celsius)
- the thermometer is set-up at 1.25-1.50m height in the shade
- we record the daily maximum and minimum

Rainfall
- is measured with a rain gauge in mm (millimeter)
- the rain gauge is set up at 30 cm height, at least 30m away from buildings and tall trees
- we record the daily total amount

Humidity
- is measured with a hygrometer in % (percentage)
- the hygrometer usually is included in the thermometer
- we record the daily maximum and minimum

Analysis of weather data:

Weather data usually are analysed per month. Do the following:

1. Determine the average temperature for each month

   Add all daily maxima and divide by the number of days → average monthly maximum
   Add all daily minima and divide by the number of days → average monthly minimum
   Add the average monthly maximum and minimum, then divide by 2
   → average monthly temperature

2. Determine the total amount of rainfall for each month

   Add all daily rainfall amounts → total monthly rainfall

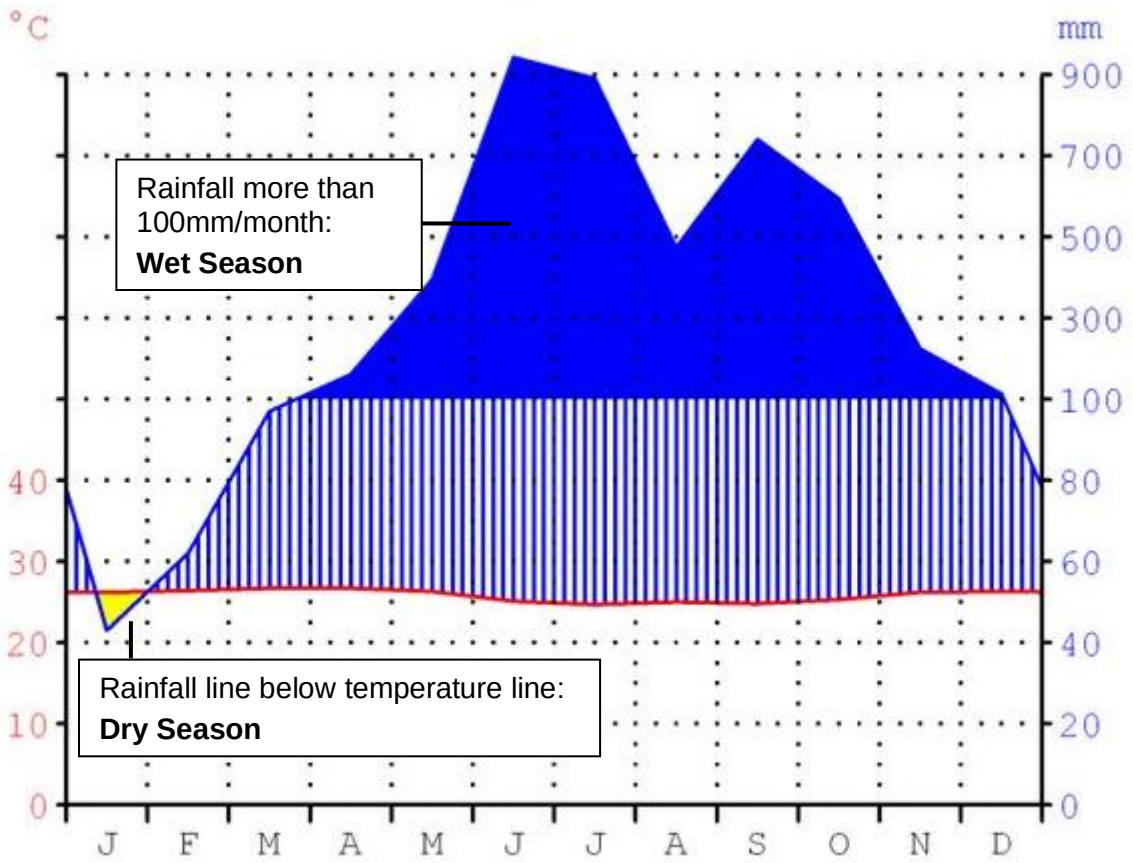
3. Draw a graph

   Put a scale for rainfall on the right-hand and a scale for temperature on the left-hand. Each 10 degrees in temperature should be the same height as 20mm in rainfall. List the months along the horizontal axis. (see example below)

4. Plot monthly data (average temperature and rainfall) on the graph

Design of graph:

Example of weather data of Monrovia:



3 Line Transect Sampling

3.1 Basic knowledge

Sampling

"How many chimpanzees are in living in our forest?" This is an interesting and important question, but not easy to answer. Actually, the exact number cannot be known, because it neither is possible to count *all* chimpanzees, nor to survey the *whole* forest. Instead the answer is estimated, as accurately as possible, by applying standardized *sampling* methods. Sampling means to take a random check of the whole population/area of interest (i.e. survey several small parts of the whole area), based upon which an estimate for the whole population/area is calculated. If the sampling methodology is well designed, then even a small number of animals counted will provide an accurate estimate of all the animals that exist in the study area. We call this a representative sample.

Let's assume, for example, that there are 1,800 chimpanzees in Sapo National Park. As the size of Sapo NP is 1,800 km², it means that the population density of chimpanzees is 1 chimpanzee per km². However, it will never be possible to count all chimpanzees or to survey the entire area of 1,800 km². So let's further assume that we conduct line transect sampling and cover an area of 18 km². In the ideal case, if we have a good sampling design, we would count a total of 18 chimpanzees, which results in the same density, i.e. 1 chimpanzee/km². So our sample would be representative for the whole study area.

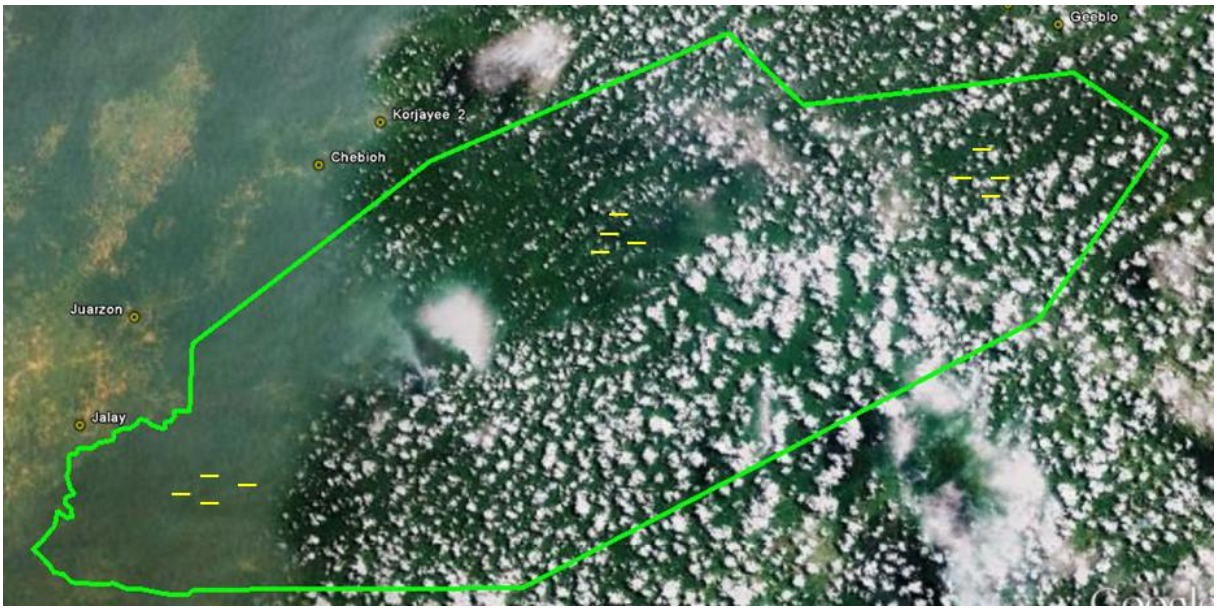
Sampling Design

How can you get a representative sample? What characterizes a good sampling design?

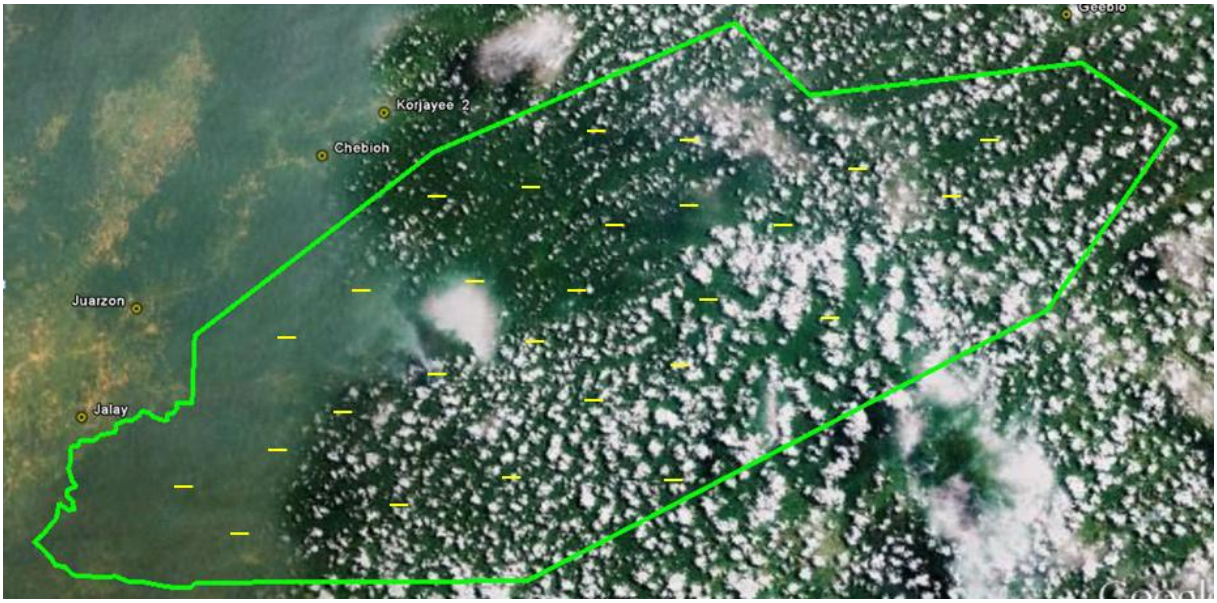
➔ There are two important criteria, i.e. the **number** and **placement** of your sampling units (e.g. your line transects). The two figures below show two different designs of line transect sampling in Sapo NP: The first one comprises in total twelve lines, arranged in 3 clusters with four lines each. The second figure shows a more evenly distribution of in total 27 lines across the whole National Park. It is easy to recognize that the second design will provide a more representative sample than the first one, because (i) it uses more sampling units, which are (ii) more evenly distributed across the whole National Park area. They do not just cover an overall bigger area, but also more different habitat types, and therefore reflect the NP area as a whole more reliably. It's easy to understand that a random placement of transects provides a more representative sample than choosing them intentionally, for example by grouping them for convenience or by sampling only areas which are easy to reach (e.g. nearby roads). The placement of lines does not have to be completely random, but usually we use a design which is called "systematic random sampling", i.e. a grid of equally spaced lines with a random starting point.

➔ Good sampling design: adequate sample size + random placement

Clustered placement of 12 transect lines



Evenly distributed placement of 27 transect lines



Sampling Methods

Depending on the aim of your study, or the animal species you are interested in, there are different sampling methods.

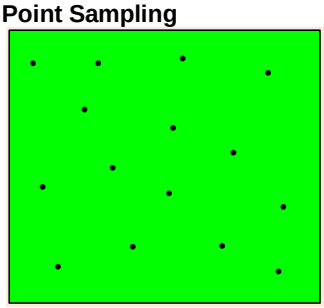
1. Point Sampling

The sample units of Point Sampling are observations posts, distributed across the study area, at which the observer stands for a defined time period and records all animals seen or heard from that location. Point sampling is often used in bird surveys and has the advantage that observation is not compromised by the noise of walking, distraction of obstacles or uneven ground.

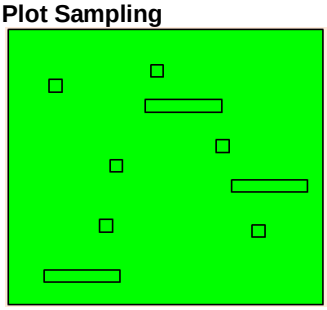
2. Plot Sampling
The sample units of Plot Sampling are areas of known size ("plots"), which can have any shape, but for convenience are generally either square (quadrates) or rectangular (stripes, also called strip transects). In Plot Sampling all objects of interest detected within a plot are recorded. It is a good method to use when surveying immobile objects such as nests or plants, which are easy to find and do not move within or out of your plot, thus preventing double counting or missing of objects.

3. Line Transect Sampling
For animal species, which are typically wide ranging and/or occur at relatively low densities, such as primates, pygmy hippos, duikers, etc., line transect sampling is considered to be most efficient, as it allows the observer to cover a comparatively large area quickly. A line transect is a trail, several kilometers long, along which the observer walks and records all animals and other objects of interest seen on either side of the line. This method is very useful for multi-species surveys and will be the method we apply for biomonitoring in the community forest. It will be described in detail in the next chapter (**3.2**).

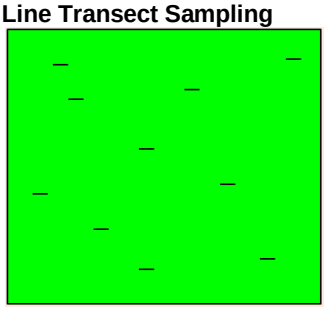
Point Sampling



Plot Sampling



Line Transect Sampling



3.2 Line Transect Sampling

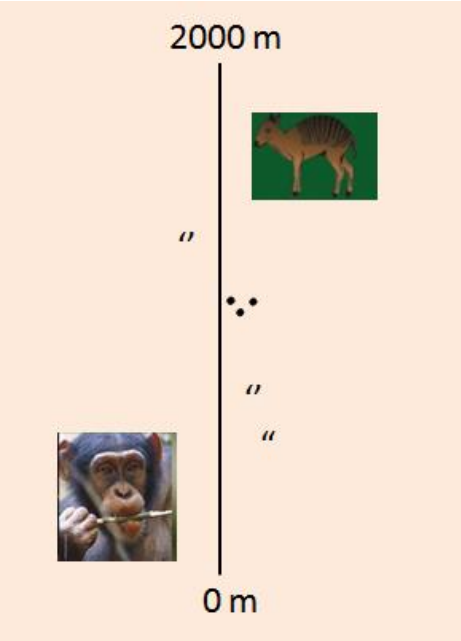
Line transect sampling (LTS) means to walk quietly and slowly along a predefined line and record all signs of interest (animals, plants, human impacts etc.) on either side of the line (see left figure below).

What kind of information can line transect sampling provide?

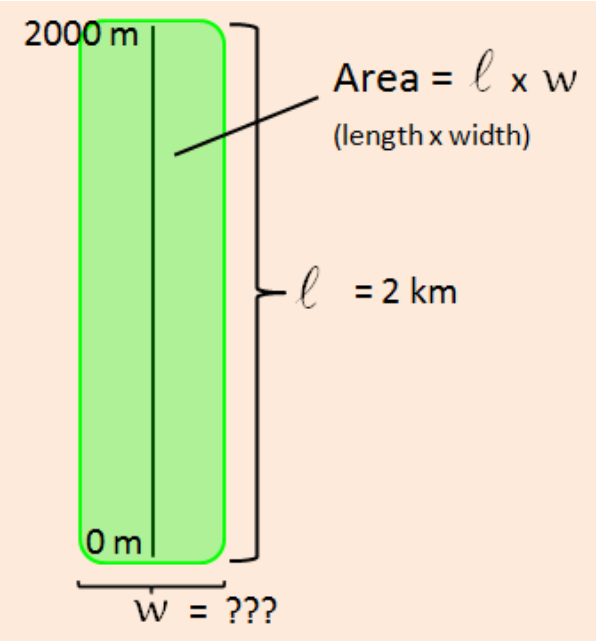
As the sampling units are lines of a given length, we know the total distance covered by the transects and can calculate encounter rates, i.e. the number of individuals per kilometer. We also call this "relative abundance". Encounter rates are useful, for example to monitor trends over years or to provide baseline information for researchers or tourists. However, they can't tell us anything about the population size of a species, i.e. the estimated total number (= "total abundance") and the density (individuals/km²). But for the management of certain species, i.e. unknown or endangered species such as chimpanzees or pygmy hippos, these figures are really important. The reason why we can't calculate total numbers is that by line transect sampling, we usually don't know the size of the **area** which we have surveyed. Area is defined as the product of length by width, but we only know the length (distance covered) of our transects (see right figure below). But in reality we have not just surveyed the line itself, but also the area left and right of it. So how can we overcome this problem? The solution is a particular method of line transect sampling, which is

called “Distance Sampling”.

Line transect sampling concept



Surveyed area is unknown

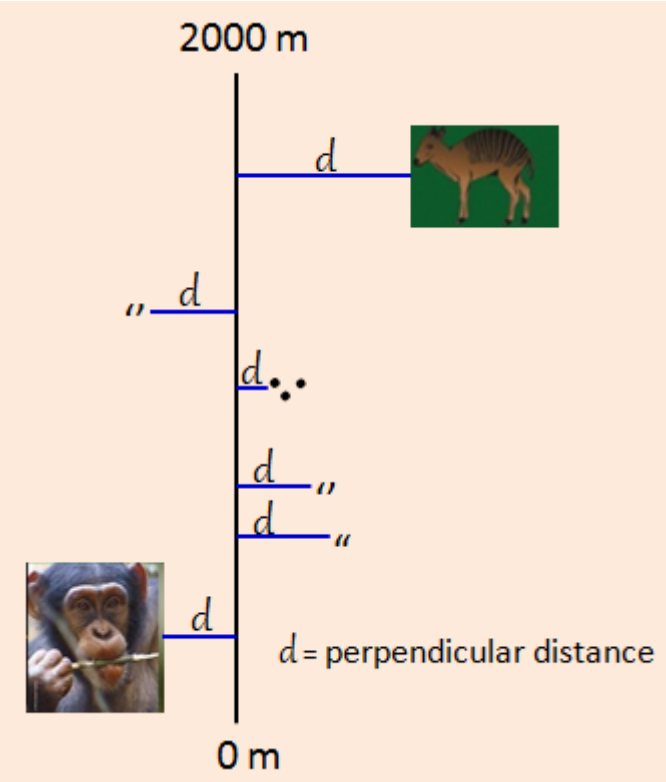


Distance Sampling

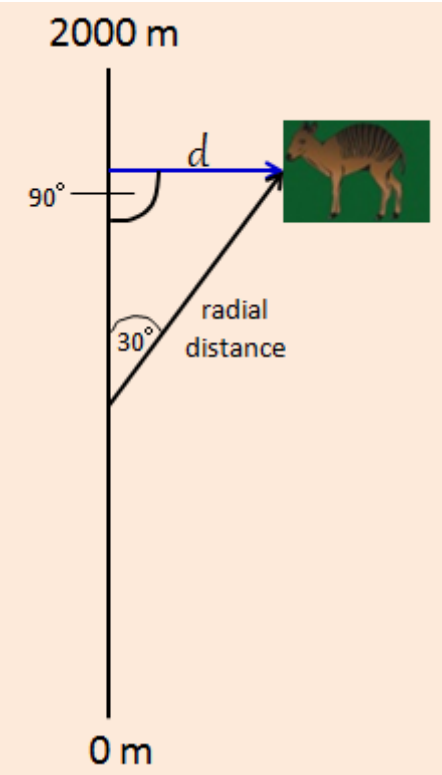
Distance Sampling is the same as Line Transect Sampling, but which, in addition to just recording the presence of animal signs on either side of the transect line, requires the exact distance measurements of the signs in relation to the transect line (see left figure below). It means for example that if we find an elephant dung pile on the right side of our transect, we have to measure how far away it is from the transect line. Distance Sampling requires the **perpendicular distance**, which is the shortest distance between the transect line and the sign (see right figure below). For better illustration the right figure below shows the difference between the perpendicular distance (“d”, = the straight blue line) and the radial distance (black line). Both measurements express the distance of the Zebra duiker to the transect line, but the perpendicular distance is shorter than the radial distance. The difference between these two measurements can also be understood by the angle between the distance line and the transect line. For the perpendicular distance, this **angle is always 90º**. You can also imagine it as a cross. It means that if you stand on the transect line, facing into the direction towards the end of the line, the sign you want to measure should be in a straight line to the right or left to you. So if you raise your arm and point into the direction of the sign, the line of your arm and the transect line should form a cross.

It is not necessary to record distance measurements of *all* animal signs, and also not of *all* species. The species we are mainly interested in in terms of population size might for example be endangered or rare species such as chimpanzees, monkeys, elephants or pygmy hippos.

Distance sampling concept



Perpendicular distance



There is a special computer programme called **DISTANCE**, which automatically will calculate population size and density estimates, based on the perpendicular distance data, which we have to enter. However, there are several assumptions and preconditions to be fulfilled in order to get reliable results:

1. Accurate distance measurements

   The perpendicular distances have to be measured accurately, and not just estimated. Use a rangefinder and a tape measure. It is further important that measurements of signs close to the line are made precisely. A common error of inexperienced observers is to record all distances nearby the transect (e.g. within 50 cm) as 0 m. This is wrong and can have a very strong negative impact on the accuracy of density estimates.

2. Transect line must be a line

   Precise measurements are only possible if the transect line is clearly defined. Therefore it is essential that the transect line is in fact a line and not a strip. The transects trails should be kept as strait as possible, i.e. allow the observers to walk unhampered, but it is not desired to cut more vegetation than necessary.

3. Objects on the line are detected with certainty

   Another assumption of Distance Sampling is that objects on the line are not missed. This assumption is generally fine for objects on the ground, but make sure that you don't miss any animals or nests directly above your head.

4. Objects are detected at their initial location

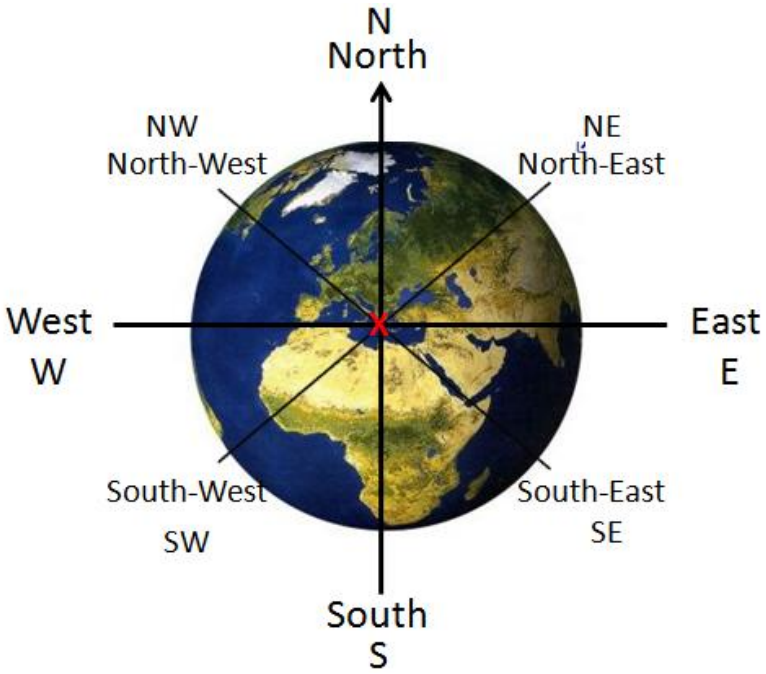
   This is fine for signs, but if animals move away from their original location before you detect them, your data are not precise. It further is important that the same animal is not counted twice within one transect survey.

5. Transect lines are placed randomly (see above “Sampling Design”)

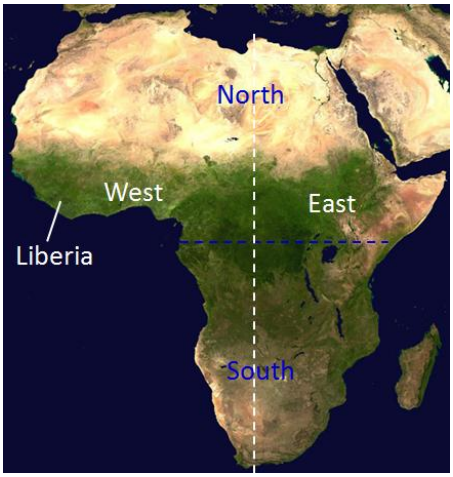
4 Navigation in the forest

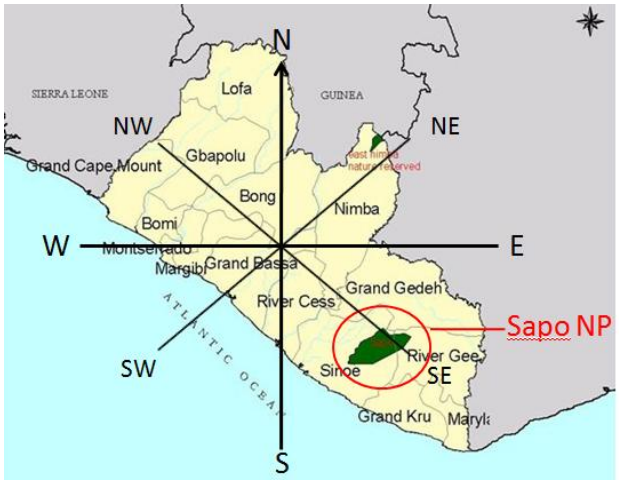
4.1 Basic knowledge

For orientation we use 4 main directions: **North (N), East (E), South (S), West (W)**. The directions between the 4 main directions are defined as North-East (NE), South-East (SE), South-West (SW) and North-West (NW).



The directions and their respective location to each other is all over the world the same and remain stable, which means that North is always on the top (of our planet), East is always on the right-hand compared to North, South is always the opposite direction of North, and West is always on the left-hand compared to North.





For example, if we look at Africa, we can say that Liberia is in West-Africa or, to be more precise, in North-West-Africa. Within Liberia, Sapo National Park is located in the South-East of Liberia (see figures above).

It also means that if you know where North is (or any of the other directions), you will automatically know where East, South and West are.

How do we know where North is?

There are several possibilities to determine the direction:

- Sun: The sun always rises in the East and always sets down in the West
- Rivers: Rivers always flow towards the ocean, which means that in Liberia the rivers generally flow in direction South-West. If you are lost in the forest, following a river can also help you, as human settlements often are nearby rivers, so if you follow a river you will sooner or later reach a village.
- Compass (see 4.2)
- Map (see 4.2)
- GPS (see 4.3)

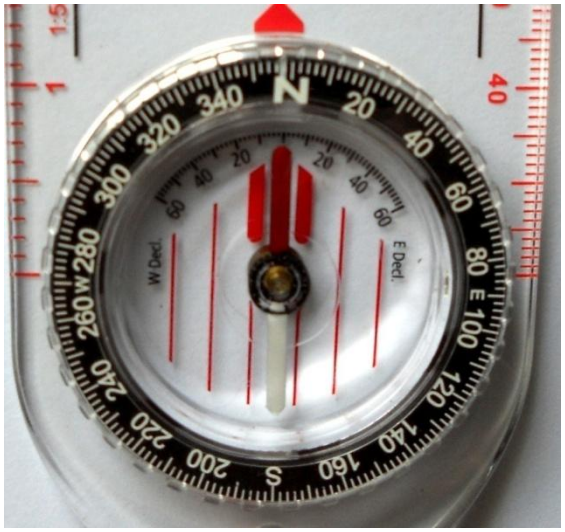
4.2 Use of compass and map

What is a compass?

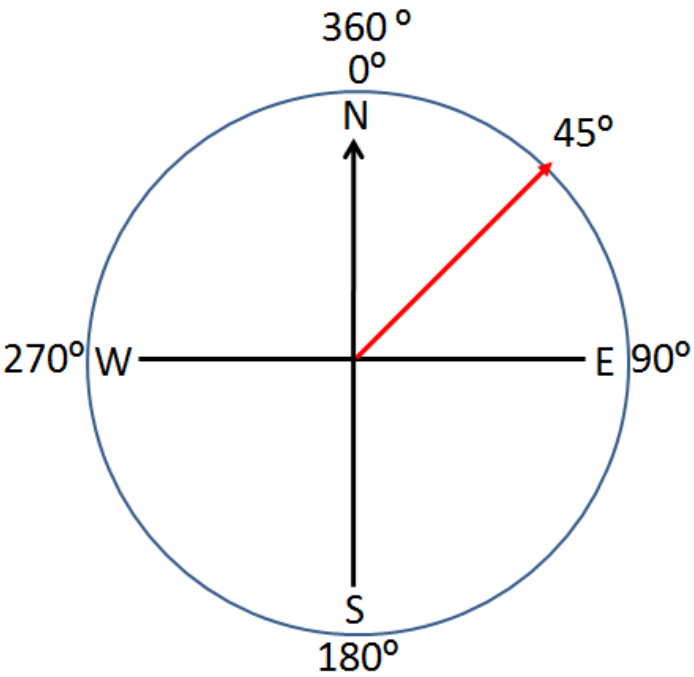
A compass is an instrument used to indicate direction. It is made of a magnetized needle that floats freely (usually in a liquid). **The needle always points North**. This is because the earth is surrounded by a magnetic field, which is strongest at the North Pole. So the magnetized needle of a compass is pulled by the magnetic field of the North Pole. Regarding the compass which we will use (RECTA DT 100), it is the **red tip** of the needle that always points North (see figures below).

It is very important to understand this basic principle of a compass. It means that the (red) needle always shows you where North is, regardless where you are. You can try and turn your body around while holding the compass in your hand; you will observe that the needle always keeps pointing the same direction.

The second important part of a compass is the **dial** surrounding the needle, on which the four main directions (North, East, South, West) are written (see right figure below). The dial is further divided into 360 degrees, the standard unit measure for directions and angles. This is because in addition to the 4 main directions there are a lot more directions (for example North-East, South-West etc.), so expressing a direction in degrees allows for greater accuracy in defining this direction. The symbol for degree is º (for example 360 º).



There are 360º in a full circle (see figure below). North always equals 0º **and** 360º, East equals 90º, South equals 180º and West equals 270º. The circle can be further broken down into single degrees for a precise definition of all the other directions. For example, North-East is exactly half way between North and East, i.e. at 45º.



Our compass indicates the degrees in 2-degree-steps, i.e. the short white lines on the dial stand for 2 degrees each (2º, 4º, 6º, 8º etc.), and the longer white lines indicate 10-degree-steps (10º, 20º, 30º, 40º etc.).

It is very important to understand that the **dial is moveable**, what means that we can turn it around. **The dial itself does not show you where North is!** It is only the red tip of the needle that always points North. To make use of the compass, you have to turn the dial and align the "N" of the dial with the red tip of the needle. Then you can read the other compass directions from the dial.

The compass further has a fixed red arrow and a fixed white line on the black ring of the dial, both of which help to read the direction (in degrees) accurately.

How to use a compass?

There are **two important general rules** to be followed when using a compass:

- Hold the compass at level in front of you, so that the needle can swing freely
- Make sure there are no iron or steel objects close to you, as they are magnetic and will distract the compass needle

A compass usually is used for two main purposes:

1. Find and keep a direction

It means that you already know the direction in which you want to go, and need the compass to tell you where this direction is.

2. Find out the direction of objects (animals, tree location etc.)

For example you see an animal and want to know its direction relative to you.

Both methods will be explained in the following. For our work, the establishing of the transects, we will mainly need the first one.

1. Find and keep a direction

Assume our transect line should be directed into South-Eastern direction (135º). You want to find this direction and keep it. Do the following:

a. Turn the dial until the desired direction (135º) aligns with the fixed white line on the black ring of the dial (see left figure below)

b. Hold the compass at level in front of you, so that the needle can swing freely

c. Make sure there are no iron or steel objects close to you

d. Turn around your body until the red tip of the needle aligns with "N" on the dial → you are facing the desired direction (see right figure below)

e. The red arrow shows you the direction you have to go

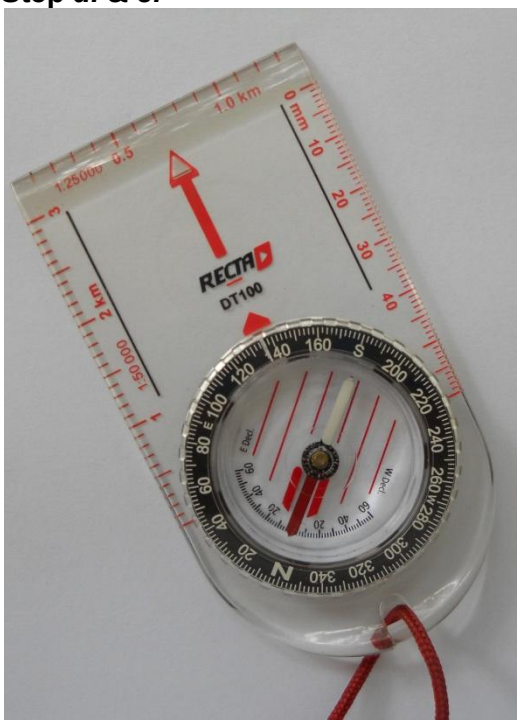
f. Find a conspicuous landmark (tree) in line with your direction

g. Go in a straight line towards that landmark

h. When you have reached the landmark, take the compass bearing again and find the next landmark in line with your direction etc., i.e. repeat steps *b*. - *g*. until you have reached your destination

Step *a*.

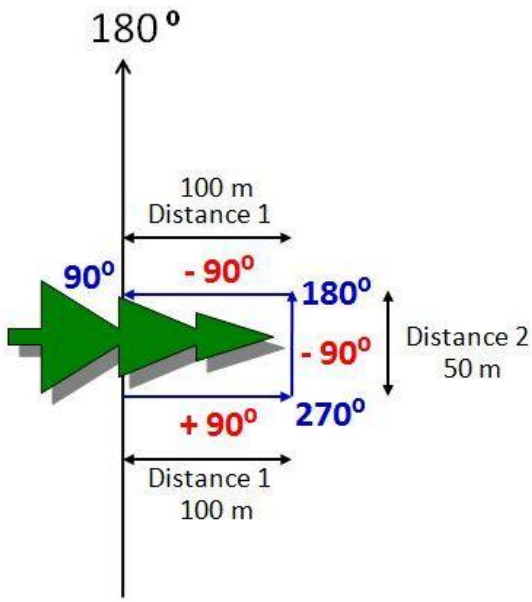
Step *d*. & *e*.



Step f. & g.

How to navigate around an obstacle?

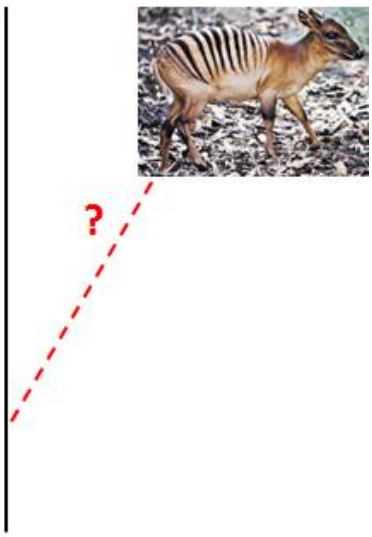
It might happen that your transect line is blocked by an obstacle such as a fallen tree. So in order to surround it, you'll have to leave your transect line and the right direction. How can you find your right line and direction again after surrounding? Do the following (for easier calculation we assume that our transect line should be in direction to 180º):



1. If you turn right: + 90º
   If you turn left: - 90º
2. Add 90º to the line transect direction and go into the new direction (270º) until the end of the obstacle
3. Measure the distance you have walked away from the transect (Distance 1, e.g. 100m)
4. Turn left and subtract 90º from your compass direction; you walk now in the same direction as your transect line (180º) until you have passed the obstacle
5. Measure the distance you have walked (Distance 2, e.g. 50m)
6. Turn left again, subtract 90º from the compass direction and walk back Distance 1 (100m) to the transect line

2. Find out the direction of objects (animals, tree, river etc.)

Assume you are on your transect and see a Zebra Duiker somewhere in the bush on the right side of the transect (see figure). You want to know its direction from your position. Do the following:



a. Turn your body into the direction of the Zebra Duiker

b. Hold the compass at level in front of you so that the red arrow points towards the animal (see figure below)

c. Make sure there are no iron or steel objects close to you

d. Turn the dial until the "N" aligns with the red tip of the needle (see figure below)

e. You can read the direction at the white fixed line on the black ring of the dial

Step *b*.

Step *d*. & *e*.

The main difference between the two described methods how to use the compass is:

1. Find & keep a direction	2. Find out the direction of objects
Dial is fixed	Your body is fixed
You turn your body	Turn the dial

Maps

So far we have learnt about different methods, which help you to find out where North (and therefore the other directions) is. However, in case you are lost in the forest, this is only helpful if you know in which direction you have to go, to get out of the forest and reach human settlements. For example, if you are lost somewhere north of your village, you would have to go towards South, in order to get out of the forest as soon as possible. But if you were lost south of your village, you would have to go towards North.

This means that you need to have an idea of the area and the relative location of important landmarks (roads, villages, camps, rivers, borders of the forest etc.). This information can be read off a map.

What is a map?

A map is a representation of a landscape. It is like a bird's eye of the world or like the view you would get from a high mountain. It helps you to understand an area. It also helps you to show others where you have been or seen an animal.

A map uses symbols to represent the features found in that area. There are different kind of maps, for example:

a. Physical map (see left figure below): focuses on features such as rivers, lakes, vegetation etc.

b. Political map (see right figure below): focuses on man-made features, such as borders between countries, villages, roads etc.

c. Hydrological map: shows water resources (rivers, streams, lakes etc.) of an area

etc.

a. Physical map of Africa

b. Political map of Africa

Usually, maps are “mixed maps”, i.e. combining physical, political etc. features (see map below). A useful map should indicate 3 important elements:

1. Orientation

   On most maps, North is towards the top of the map. But this must not always be the case. Therefore, any map should clearly indicate which way is North. Once North is defined, any other direction (East, South, West) is evident. There are different symbols for indicating the orientation of the map – simple arrows pointing North (as in the map below), or more complex symbols:

2. Scale

   A map must include a scale in order for it to be useful as a source of spatial information. Scale refers to what a given distance on the map represents on the ground. Scales are usually presented in two ways. First, the scale can be presented **graphically** as a bar, indicating to how many kilometers a certain distance on the map refers (see the map

below, it means that 0.5 cm on the map corresponds to 20 km in reality, or, for easier calculation, 1 cm corresponds to 40 km).

As an example you can calculate the distance from Greenville to Monrovia. Measure the distance with a ruler, e.g. 5.5 cm, and then multiply this number by 40km (because on that map 1 cm corresponds to 40km). The distance between Greenville and Monrovia is therefore 220 km.

Second, the same information as given by the graph can be expressed **numerically**, as a ratio between the distance on the map and the distance on the land. Usually it indicates the corresponding value of 1 cm on the map compared to the real distance in cm on the land. For example, on a map with a scale of 1:50,000 (read 1 to 50,000), 1 centimeter on the map represents 50,000 cm on the ground. As 100 cm are 1 meter, we can also say that 1 cm on the map represents 500 m on the ground.

As in the figure below 1 cm corresponds to 40km, the numeric scale of this map is 1:4,000,000 (as 1 kilometer is the same as 100,000 centimeters).

3. Key of symbols

Any feature and symbol used in the map should be defined in the map's key. For example, roads, rivers, national borders, airports, towns, villages etc. can have their own symbols. Landscape features such as elevation or vegetation types often are defined using different colours.

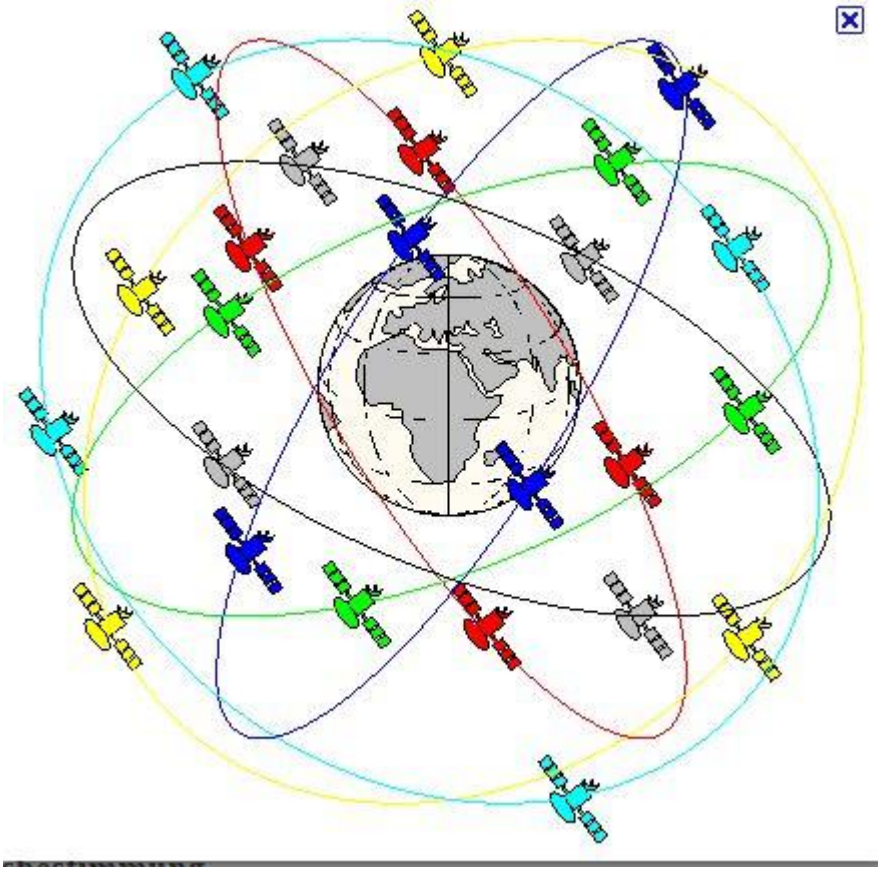
Map of Liberia, showing physical, political, hydrological etc. features. It also contains the 3 important elements *orientation*, *scale* and *key of symbols*.

4.3 Use of GPS

What is GPS?

GPS stands for **G**lobal **P**ositioning **S**ystem. It was established by the United States of America in 1970. A GPS can tell you where on earth you are. It receives signals from satellites, which are orbiting in approximately 17,500 km height above the earth. Today there are 24 satellites, which regularly send signals with an exact time code. As soon as the signal reaches the GPS, it can calculate the time difference between sending and receiving this signal, and therefore "know" how far it is away from the satellite. The GPS needs to receive signals from at least three different satellites in order to calculate its exact position.

Satellites orbiting above the earth

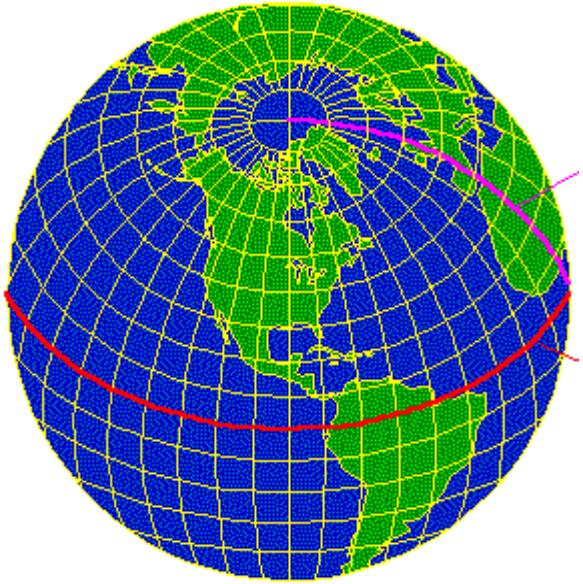


The reception of signals is restricted or blocked inside buildings, by mountains or very dense vegetation, but not affected by a cloudy sky. The GPS unit we use (GARMIN GPS MAP 62S) has a very strong antenna and therefore is able to capture enough satellites even under the rainforest canopy.

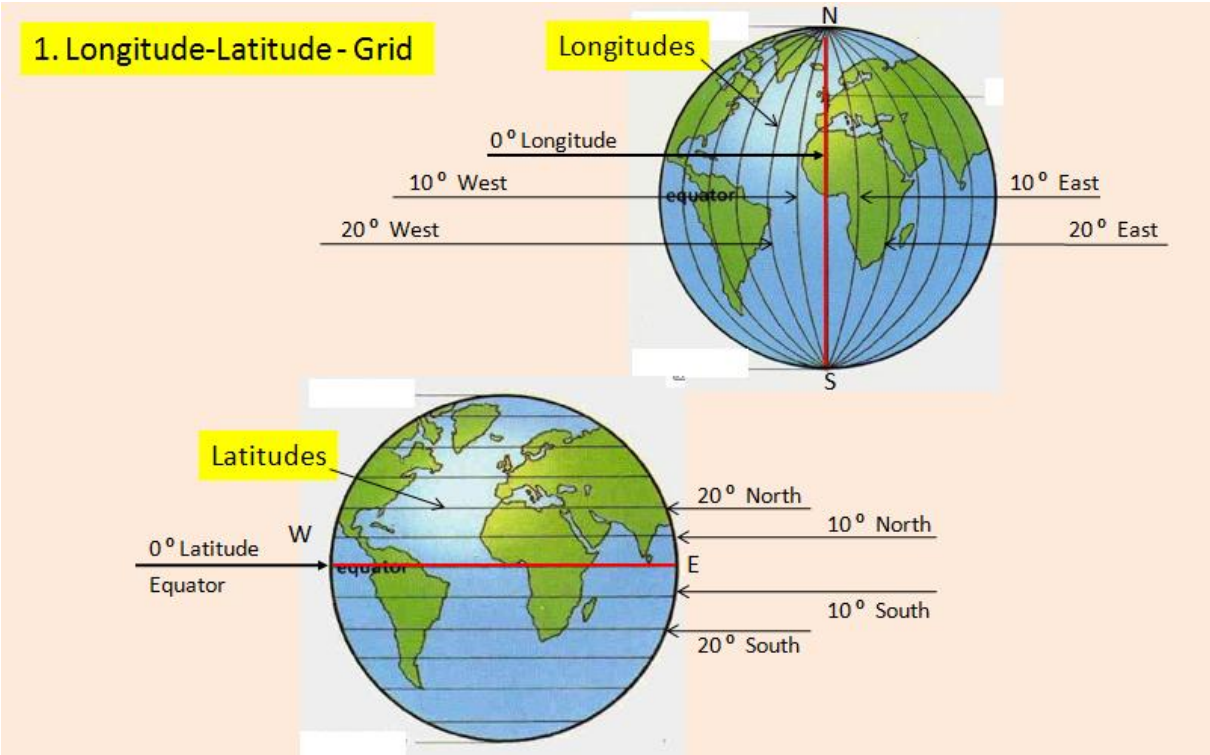
What does the GPS tell you?

To describe a position on earth we use a global coordinate system. This can be imagined as a grid layer on the earth's surface (see figure below). It specifies every location on Earth by a set of numbers. There are different type of grids, using different number codes. The two most common are the "Longitude-Latitude-Grid" and the "UTM-Grid".

Global coordinate system



1. Longitude-Latitude-Grid

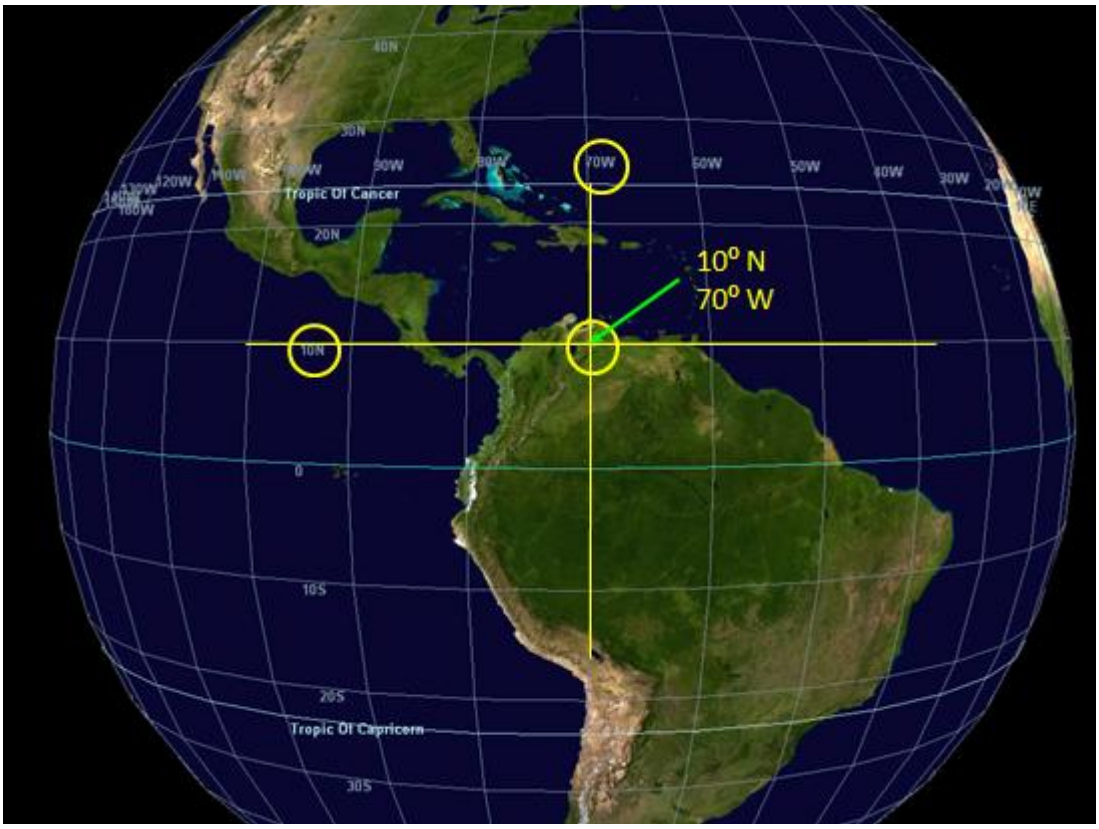


This system defines the vertical lines of the grid (i.e. the ones running from North to South) as longitudes and the horizontal lines (running from West to East) as latitudes. They are defined in degrees. The 0º longitude runs through Greenwich (near London in the UK) and West-Africa. Locations east of this line are defined as “degrees East”, i.e. º East (for example 10º E etc.), and places west of this line as “degrees West” (for

example 10º W etc.). The 0º latitude is also called equator and divides the globe into the Northern and Southern Hemisphere. Places north of the equator are defined as “degrees North” (for example 10º N etc.) and places south of the equator as “degrees South” (for example 10º S etc.).

The combination of the longitude and latitude specifies the position of any location on the planet, indicated by two numbers (i.e. degrees longitude and degrees latitude).

Specification of a position using the longitude-latitude grid

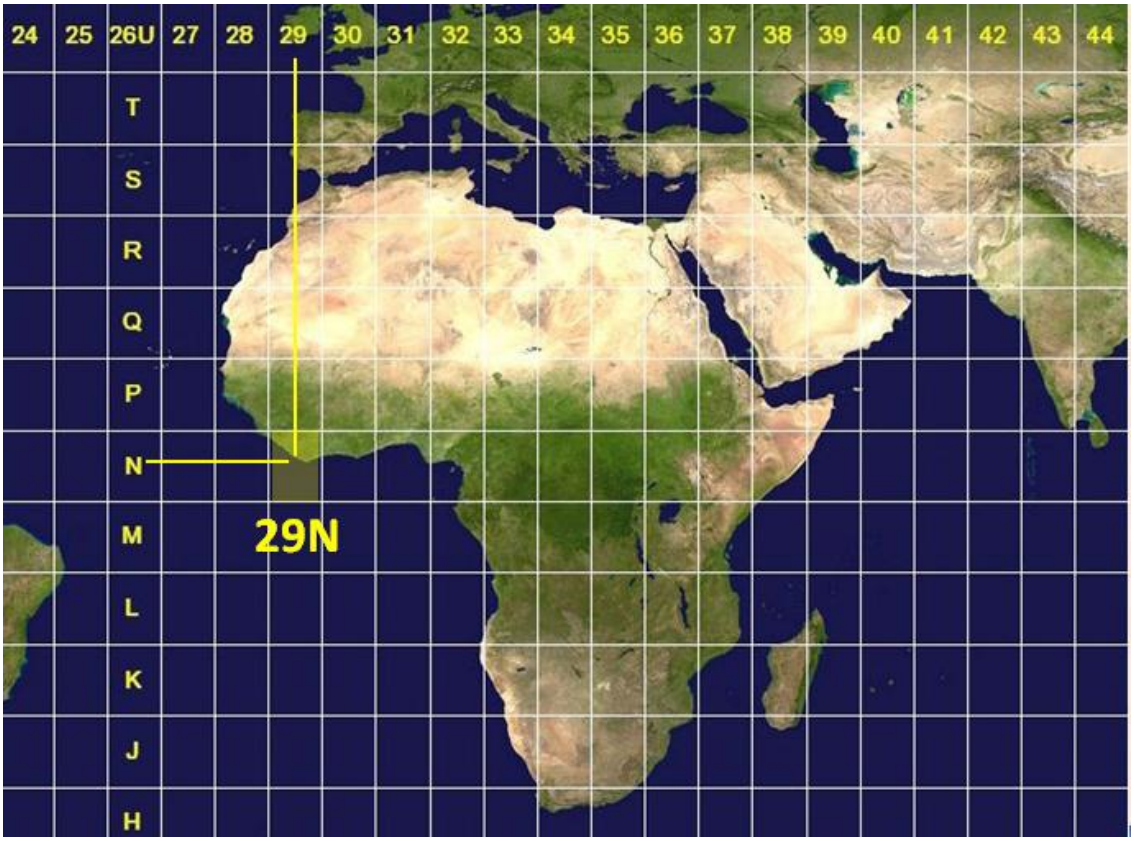


2. UTM-Grid

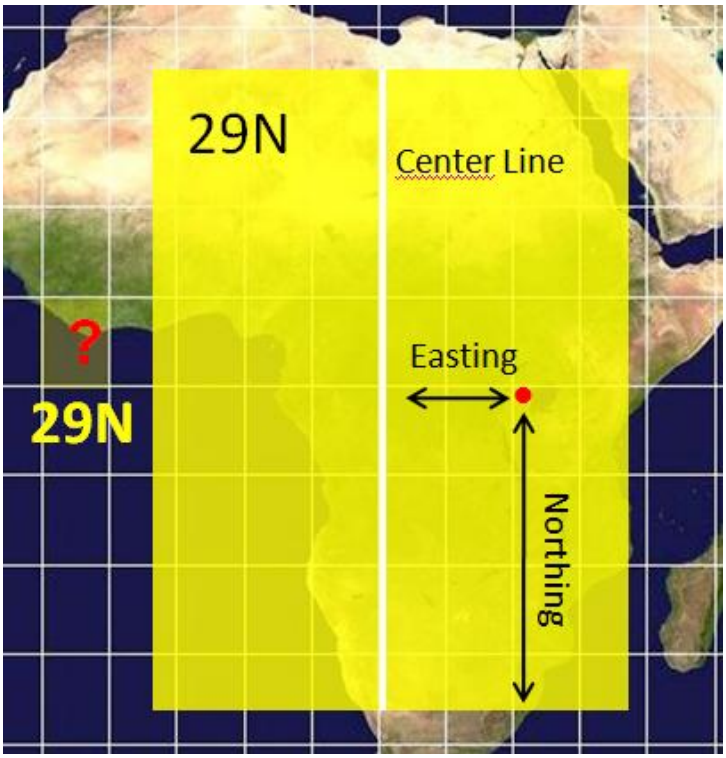
The UTM (Universal Transverse Mercator) coordinate system uses a metric-based grid. It divides the surface of Earth from West to East into 60 zones, each 6° of longitude in width. Zone 1 is bounded by longitude 180° to 174° W. Zone numbering increases in an easterly direction. From North to South the zones are defined by letters. This means that each zone has a two-digit code, i.e. a number and a letter. Liberia for example is located within Zone **29N** (see figure below).

The exact position of a location within a zone is specified by a **Northing** and **Easting** coordinate pair, expressed in meters. The Northing specifies the distance of the location from the equator in meters, and the Easting specifies the distance of the location from a (hypothetical) centre line (which is dividing the zone into two equal parts; imagine this line running from North to South through the center of the zone). To avoid negative values for positions west of the center line, the center line is defined to be located at 500,000 meters.

Part of the global UTM-Grid, showing the location of Liberia within Zone 29N



Specification of a position (red dot) within a UTM zone

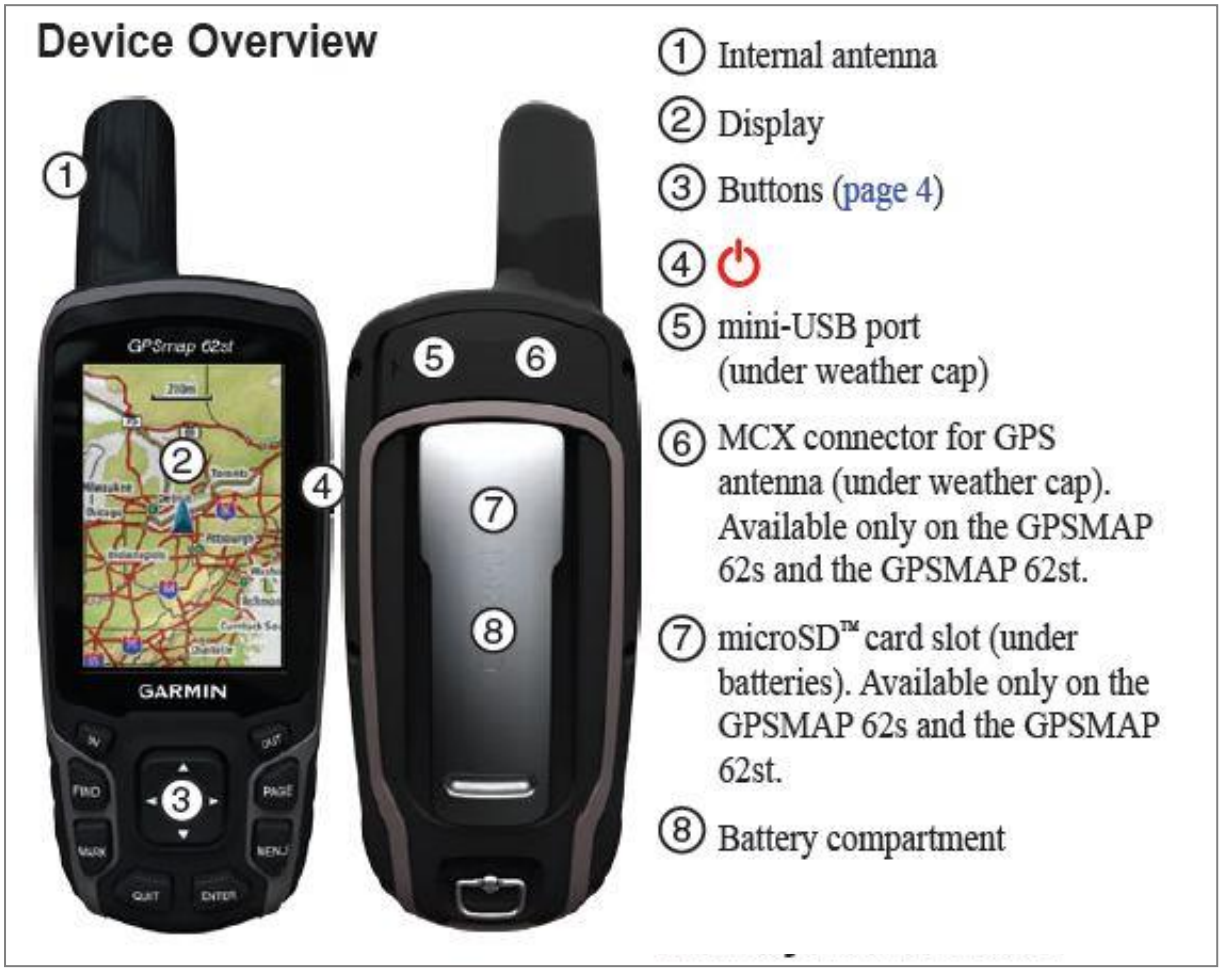


The position of any location on Earth by UTM is therefore defined by the **Zone**, the **Northing** and the **Easting**.

We will work with the UTM based coordinate system. The following figure shows how the position of a location (i.e. “Tini’s Hut”) is indicated on the GPS. The left part in the location field indicates the UTM Zone (which is, as explained above, 29N for Liberia), and on the right you can read the two coordinates. The upper number (0520646) is the **Northing** and the lower number (0591758) is the **Easting**. It means that this location is 520,646 meters (= ca. 521 km) north of the equator and 91,758 meters (= ca. 92 km) east of the zone’s center line (which is defined to be at 500,000 meters).

The main functions of a GPS

Overview



Buttons

FIND	Press **FIND** to open the search menu.
MARK	Press **MARK** to save your current location as a waypoint.
QUIT	Press **QUIT** to cancel or return to the previous menu or page.
ENTER	Press **ENTER** to select options and acknowledge messages.

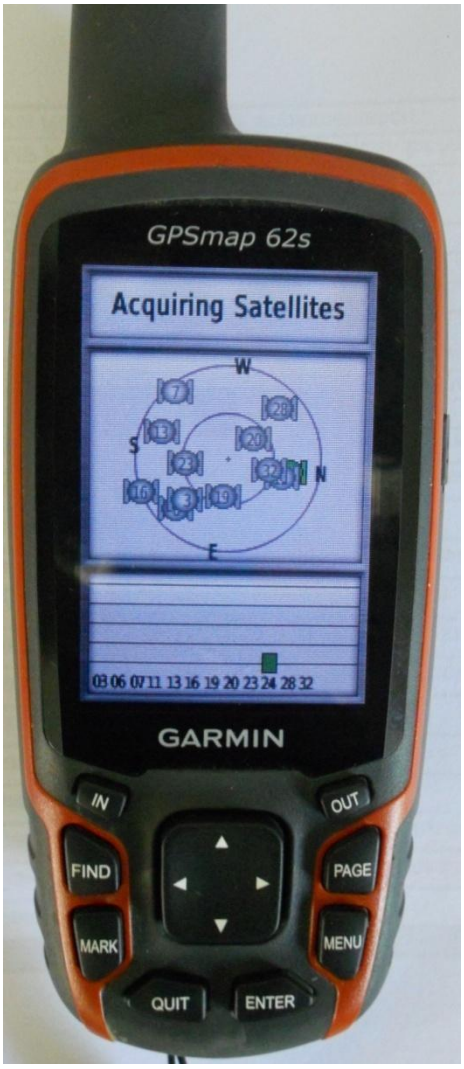
PAGE	Press **PAGE** to scroll through the main pages (page 11).
Rocker	Press up, down, right, and left to select menu options and to move the map cursor.
IN	Press **IN** to zoom in on the map.
OUT	Press **OUT** to zoom out on the map.

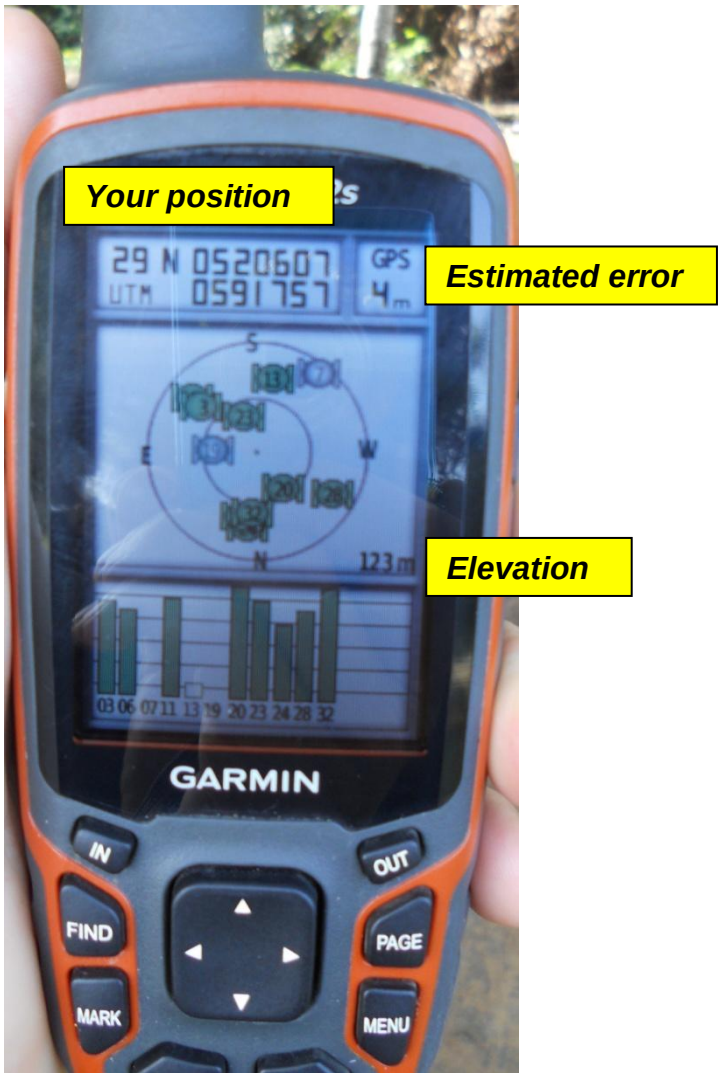
MENU	Press **MENU** to open the options menu for the page that is currently open. Press **MENU** twice to open the main menu (from any page).

As a basic principle, the contents and functions of a GPS are arranged in “pages”. The **Page** button allows you to run through all the pages. There are a lot of different pages (e.g. “Satellite”, “Track Manager”, “Map”, “Calendar”, etc.), and depending on your individual need and purpose you can choose which ones should be displayed. For our work, we will mainly need three of them: **Satellite**, **Map** and **Waypoint Manager**.

Satellite Page

If you switch on the GPS, the first page that appears automatically is the “Satellite Page” (see figures below). This page informs you about how many satellites the GPS receives. It shows the position of each satellite which should be available and which are currently being detected by the GPS unit. The position of each and whether it is being detected is shown as a circular diagram; the strength of each satellite signal as a series of bars along the bottom of the screen.
Before you can make use of the GPS, it has to receive signals from at least three satellites to locate its position. As long as the GPS is still searching, the text “Acquiring satellites” appears on the top of the display (left figure below). As soon as it receives enough satellites your position will be displayed in the headline (right figure below). As explained in the previous section, your position is indicated by three parameters: the UTM Zone, the Northing and the Easting.





You can observe that it will take a while until the coordinates remain stable. If you start walking around they will also change (because you change your position), and as soon as you stop, it will again take a while (depending on how good the reception is) until the coordinates remain fixed. So in order to get an accurate information of your location, always wait a bit until the displayed coordinates don't change anymore.

Right next to the position coordinates the estimated error is shown (in the example above it is 4 meters). This means that in reality the position shown on the GPS might be 4 meters away from your actual position. On the right bottom of the circular shaped satellite field you can see another number, which refers to the elevation of your position above sea level (in our example it is 123 meters).

Map Page

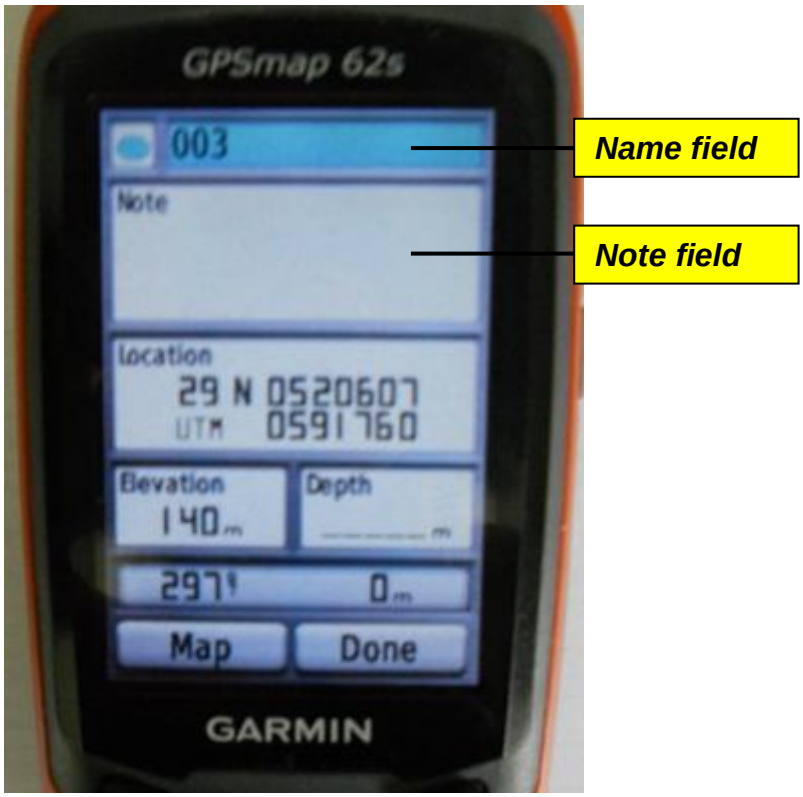
If you press the **Page** button, you will enter the next page, i.e. the Map Page. It shows in a more illustrative way where you are. The **blue arrow** marks **your position**. Use the rocker to navigate through the map. The **white arrow** is **moveable** and can be moved by the rocker to any place on the map, in which you are interested (e.g. to a road or a river etc.). This is for example helpful, if you want to know how far this place is from your position, or in which direction you will have to go to reach this place. The information on the **location** of the **white arrow** is displayed in the white field on the **top** of the screen: the UTM zone, its Northing and Easting coordinates, as well as the distance and direction relative to your position.

The map also indicates a scale (i.e. in our example above, the length of the black line corresponds to 120 km), which can be changed by using the “Zoom in” and “Zoom out” buttons.

How to save your position (= create a waypoint)

If you want to save your position, press **Mark**. A window will pop up (see figure below), showing several fields with the details of your position (such as the location (UTM Zone, Northing and Easting coordinates), elevation etc.), and which allows you to edit your waypoint. Editing means that you can give your waypoint a name and add a note. The name of the waypoint is displayed on the top of the screen. As a default, the GPS gives all waypoints automatically a number (e.g. 003). Below the name field you’ll find the note field. You can navigate through the waypoint window using the Rocker. The field, which have you have selected will be highlighted in blue.

The waypoint window (this appears after pressing Mark).

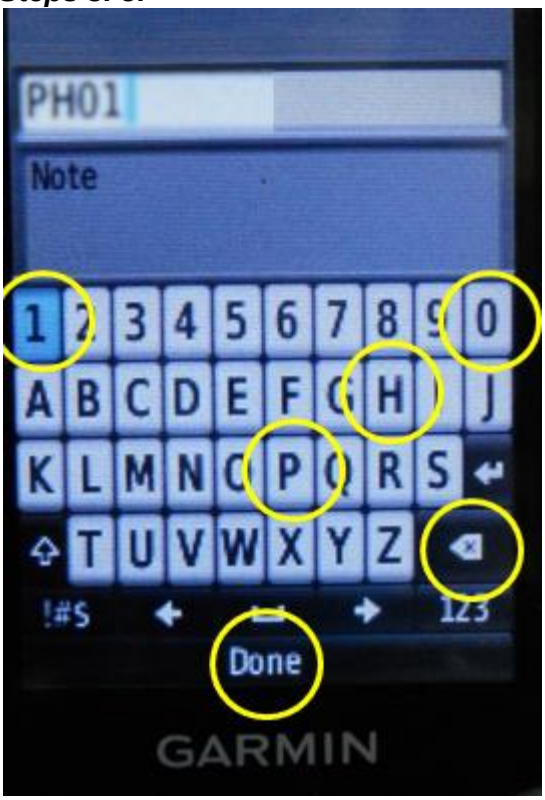


Let’s assume we are on a survey and have found Pygmy Hippo dung. We want to save its location, give it the name “PH01” and make a note “Dung”. Do the following:

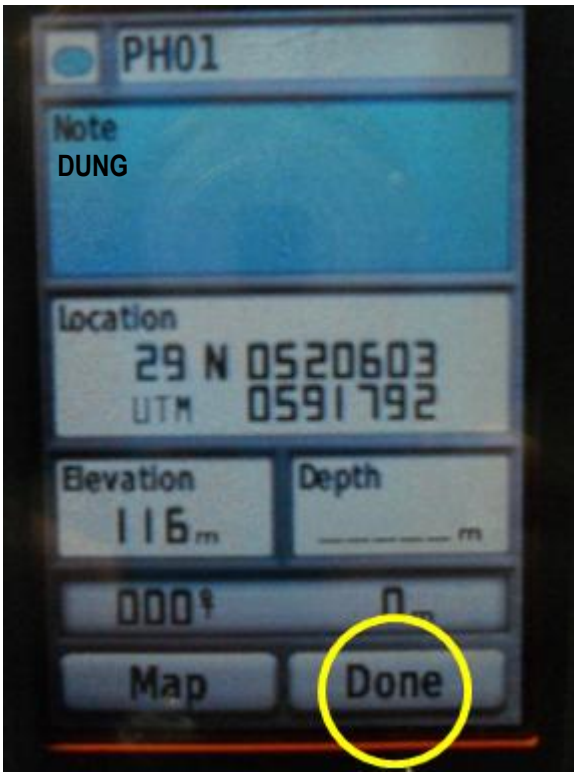
1. Press **Mark** → the waypoint window will pop up
2. Use the Rocker to navigate to the name field (as soon as you reach it, it will be highlighted in blue)
3. Press **Enter** → a small window will pop up showing letters and numbers (see left figure below)
4. Use the Rocker to select a letter (e.g. P). The respective letter will be highlighted in blue. Press **Enter** to choose the selected letter. It will appear now in the name field. Then navigate to the next letter (H) etc.

5. If the name is entered press **Done** to save the name and return to the waypoint window
6. Next use the Rocker to navigate to the note field. Press **Enter** → a small window will pop up showing letters and numbers. Create the note *Dung* by following the same procedure as described above for the name (i.e. steps 4 and 5)
7. As soon as we have entered the name and note, we are finished. **To save your edited waypoint you must confirm it by pressing the Done button on the right bottom of** the waypoint window (see right figure below)

Steps 3.-5.



Step 7.

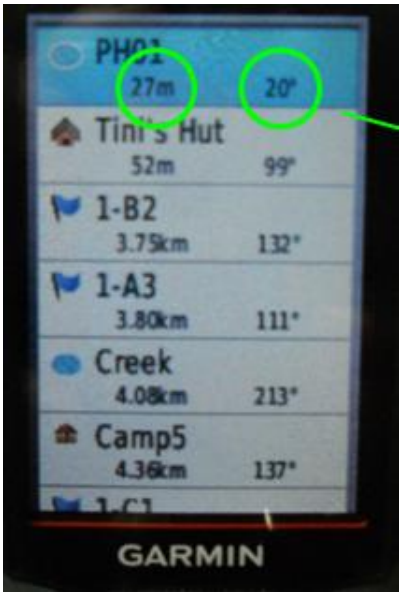


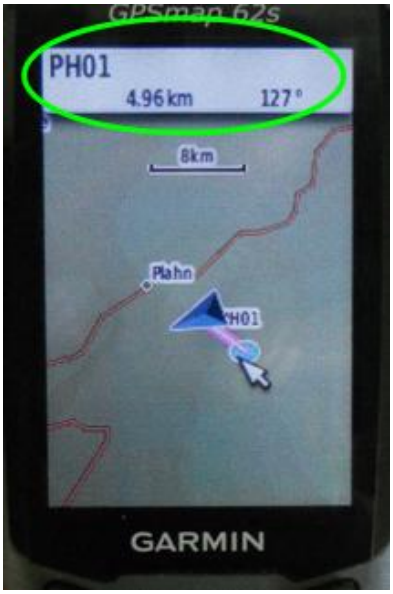
! *NOTE*: *Before saving a position, it is important to wait until the coordinates remain stable. As explained above (see the section on "Satellite Page"), depending on the satellite reception or if you have been moving around, it might take a while until the GPS displays the correct location. The best way to check if your coordinates remain stable is using the* **Satellite Page**. *Press the* **Page** *button several times, until you'll reach the* **Satellite Page.** *Check the coordinates displayed on the top of the screen. As soon as they don't change anymore you can save your position by pressing* **Mark** *and following steps 1-7 described above.*

We have successfully created the waypoint "PH01". But where can you find your waypoint in the GPS now? → All waypoints are stored in the **Waypoint Manager**. You can reach it by pressing the **Page** button several times.

Waypoint Manager Page

This page lists all waypoints which you have ever created (e.g. left figure below). In addition to the waypoint's name, its distance and compass direction compared to your current position is shown. The waypoints are listed in order by increasing distance to your current position. It means that the nearest waypoint is always on the top etc. In our example below, it means that the waypoint PH01 is 27 meters away from you, in the compass direction of 20º – in other words if you would go 27m towards 20º, you would reach PH01.
Use the Rocker to navigate through the page. The selected waypoint will be highlighted in blue (as PH01 in our left example below). If you press **Enter** the waypoint window will pop up, showing details of the waypoint such as the Location, Note etc. (see center figure).



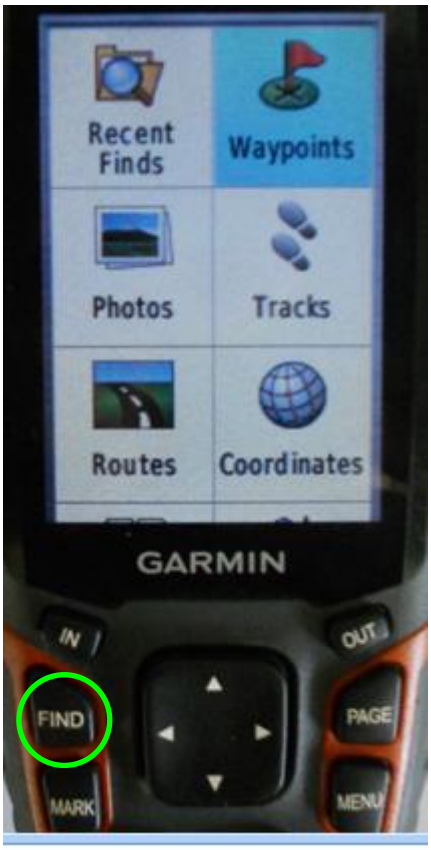


You can use the GPS to navigate to the selected waypoint in the field. For example you want to show somebody the location where you have found the Pygmy Hippo dung, but cannot remember its exact position in the forest. The GPS will help you to find it:

In the waypoint window you press **Go** (center figure above). The **Map** Page will pop up (right figure above), showing your current position (= **blue arrow**) and the PH01 waypoint. As soon as you press the Rocker for navigation, the **white moveable arrow** will appear. At the same time, the details of the position of the white arrow (location, distance and compass direction compared to your position) will be displayed in field on the top of the screen. Use the Rocker to move the white arrow until it aligns with the waypoint PH01 on the map. As soon as it matches with your waypoint, the name of the waypoint (PH01) appears in the top screen field (right figure above). You can also read how far and in what compass direction PH01 is located compared to you (e.g. 4.96 km and 127º). Use the compass to find out in which direction 127º is. Navigate to PH01 by using the compass as described in Section **4.2** (**Find and keep a direction,** page 18), while at the same time using the support of GPS (It is easier to find and keep a direction with the compass, because with the GPS you would have to move constantly with a certain speed to get a

reliable information in which direction you go. However in dense vegetation of the forest this is often not possible. The advantage of the compass is that it reliably shows you the direction even if you move very slowly or stop. In addition to the compass it is helpful to use the **Map** Page of the GPS to give you a better idea where you are in relation to your final navigation aim).

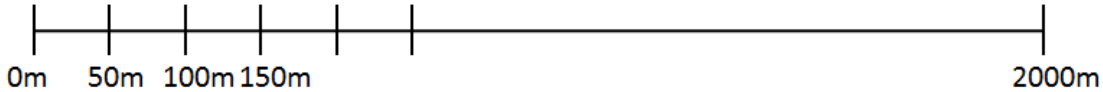
As described in the previous section, you can find and navigate to a waypoint by using the **Waypoint Manager** Page. For the sake of completeness it should be mentioned that there is a second way to find a waypoint, i.e. using the **Find** button (see figure below). If you press **Find**, the display below will appear, giving you different options to choose, among others the "Waypoints". If you press **Enter**, the **Waypoint Manager** Page will pop up. Use it as described in the previous section.



5 Habitat description

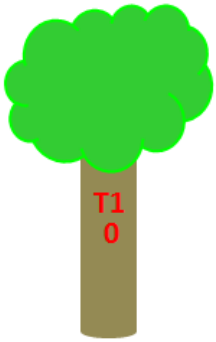
Habitat characteristics (such as forest type, water resources, fruiting trees etc.) are important because they influence the occurrence and distribution of animals. Therefore it is important that we describe our transects.

How to describe the habitat characteristics of the transects



Every 50m:

1. Mark tree with red paint 0m: **0** ; Transect Number (for example **T1**)
   50m: **50**
   100m: **100**
   ..etc...
   2000m: **2000** ; Transect Number (**T1**)



2. Fill **Habitat Description** form

Habitat Description - Transect No.:

Transect No.: **Date:** **Team:** **Cutting direction:**

	Forest Structure						Topography		Water resources	Notes
Meter	Type	Tree species	Tree height	Lianas	Canopy cover %	Ground cover %	Level	Elev.		
0										GPS Data
50										
100										
150										
200										
250										
300										
350										
400										
450										

<u>Explanation</u>

Headlines

Transect-No.: The “ID-Number” of transect (e.g. T01)
Date: self-explaining
Team: self-explaining
Cutting direction: enter point and compass bearing (e.g. T01S, 90°, if you start

cutting Transect No. 1 from the starting point and from West to East; or T01E, 270° if you start at the ending point and your cutting direction is then vice-versa, running from East to West which corresponds to 270°)

Forest Structure

Type (= Forest Type):

Primary Forest refers to untouched, pristine forest that exists in its original condition. This forest has been relatively unaffected by human activities or other disturbance. Primary forest is characterized by large, old trees, a full ceiling canopy and usually several layers of understorey. The ground floor is generally clear of heavy vegetation because the full canopy allows very little light, necessary for plant growth, to penetrate. Occasionally, when a canopy tree falls, a temporary light gap is opened in the canopy, allowing growth of floor and understorey species. Primary Forest is the most biologically diverse type of forest.
Secondary Forest is a forest that has been disturbed in a wide scale, either naturally (by fires, floods, land-slides, wind throw etc.) or by humans (logging, clear cutting, slash-and-burn etc.), and then left to regenerate. Depending on the level of degradation, secondary forest generally is characterized by a less developed canopy structure, young and smaller trees, less diversity, and, as more light reaches the floor, a dense ground vegetation. As times passes since the initial disturbance, both the species composition and the structure of the forest will change gradually. This gradual change is known as “forest succession”. Initially the land will be covered by weedy shade-intolerant plants and shrubs that thrive in open light conditions and grow and reproduce quickly. Within a year, a few, thin trees will appear above the dense ground vegetation. With time a taller, more closed-canopy forest, characterized by many small and medium-sized trees will be observed, and the ground vegetation will become less dense. This forest can be described as ***Young Secondary Forest***. With the passage of time, the forest will further change in terms of structure and species composition and gradually will turn into an ***Old Secondary Forest***. If it will remain undisturbed and experience little change in species composition and structure over a long time, it will become again a Primary Forest.

It is sometimes difficult to distinguish between Primary and Old Secondary Forest, because we do not know, how old a forest is and how long it has been undisturbed. In general the forests of West and Central Africa mostly are very Old Secondary Forests. So for the habitat description we will only distinguish between **PF** (Primary/Old Secondary Forest) and **YS** (Young Secondary).

Farmbush is an open, regenerating area which has recently been used by humans for plantation etc. It is not a forest yet, i.e. usually lacks of trees, but mainly contains weedy plants, creepers and shrubs.

Thatch we call an area (usually in the forest) which is covered heavily by thatch plants. In the habitat description we will add this information to the forest type (e.g. **PF** + **TH**).

***Note**:* Local people often use the term “Low Bush”, which refers either to (very) Young Secondary, Farmbush or the (naturally low-growing) vegetation that can be found close to rivers. This term should be avoided in the habitat description sheet, as it is not specific. Only use the terms explained above.

Tree species:

It is not necessary to identify the various tree species around the 50m mark, but just to mention if it is a mixture of different species or if one species is dominant. For example in a swampy area, *Raphia* palms might dominate the overall tree species composition. Use the abbreviation **MIX** for a mixture composition and **DOM** for dominant. In the latter case, also specify the dominating tree species in the "**Notes**" column (last column of sheet).

Tree height:

Estimate the average height of the higher trees around the 50m mark. Use 5-meter-intervals.

Lianas:

Lianas are long-stemmed, woody creepers that are rooted in the soil at ground level, but cannot support themselves and therefore use trees as well as other means of support to climb up to the canopy in order to get access to sunlight. They are characteristic of tropical rainforests and often dominate the middle-storey, forming bridges between the trees and canopy, providing animals with paths across the forest. The amount of lianas present in the area surrounding the 50m mark will be described with numbers from 0 – 3 (0 = none, 1 = few, 2 = medium and 3 = many).

Canopy Cover:

If you look up to the sky, how much of the sky is covered by the canopy? This will be expressed as percentage, by using 25% intervals:

0-25% means that the canopy is very open, i.e. less than a quarter of the sky is covered

25-50% between a quarter and half of the sky is covered

50-75% between half and three quarter of the sky is covered

75-100% means that the canopy is very closed, you cannot see much of the sky

Ground Cover:

How much of the forest floor is covered by the ground vegetation? Again use percentage and 25% intervals:

0-25% easy to walk, i.e. less than a quarter of the floor is covered

25-50% between a quarter and half of the floor is covered

50-75% between half and three quarter of the floor is covered

75-100% floor densely covered

Topography

Level:

We distinguish between lowland (plain, flat area), slope (going up or down a hill) and ridge (top of a slope, hill). Use the abbreviations as explained in the form's key (LL for lowland etc.).

Elevation:

The elevation is the height above sea level (it means how high your area is compared to sea level, which is defined as 0 meter). You can read the elevation from the GPS. It should be expressed in meters.

Water resources

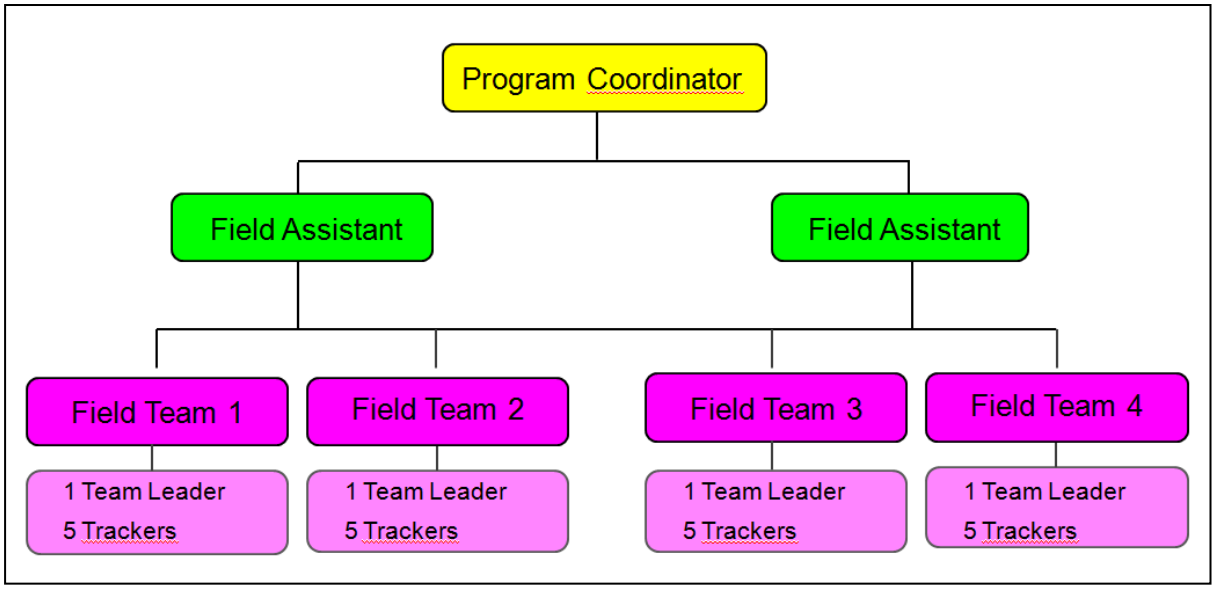
Describe if there are any water resources (stream, creek, swamp, pond etc.) nearby the transect, or if the area is (seasonally) flooded.

Notes

Here you fill in if there are any special features along the transect, for example a big gap in the canopy due to a fallen tree, hunter or miner camps etc. These features will not always be located exactly at the 50m-marks, but nevertheless they should be recorded. If you encounter anything interesting between two 50m marks, just record it in the note column of the nearest 50m mark (If, for example, the transect line passes a huge treefall at 90 meter, take a note on that in the 100m row of the Note column). Secondly, the Note column should be used to specify the dominant tree species, in case the “Tree species” column was filled in by **DOM**, and to note the GPS coordinates of the starting and ending point (it is not necessary to save <u>all</u> 50m mark coordinates, only the starting and ending).

6 Logistics and planning of field trips

Who is responsible?



Program Coordinator:	Overall supervision of biomonitoring program
Field Assistants:	Coordinate logistics and field operations together with Team Leaders
Team Leaders:	Plan, organize and supervise field trips of their team, together with Field Assistant

Important steps for planning a field trip

1. Plan ahead!
   - Make sure you start planning and preparations in time! Usually one month before your actual field trip should give you enough time for thorough preparation.
   - Think about:
     When *do you plan to go in the forest?*
     Who *will be on the team?*
     Where *do you want to go?*
     How long *will be your field trip?*
   - Write down the key bullet points of your plan
2. Hold a team meeting
   - Inform your team members of the plan and discuss it together
   - Make a list of the field equipment you will need

- Check the field equipment
- Make a list of food you will need (think about the quality, quantity etc.)

3. Submit your request of food and equipment needed to the Field Assistant in time!

4. 2-3- days before departure: Final planning and packing together with the team

7 Ethical behaviour in the field

7.1 Team spirit

The success of each field trip, and sometimes even the lives of the team, depend on the responsible behaviour of all team members. It is important to understand the need for team spirit, which is best characterized by the following:

- We are one team
- We respect and help each other
- All team members are equal
- All team members play an important role
- Every team member has certain responsibilities

The team should have a team leader, whose main responsibilities are to plan and supervise the field trip and assign tasks to the other team members. S/he should control the medical kit, using a list to make notes of the patients, dosage and kind of medication used for treatment. S/he further must make final decisions in emergency cases. Although the leader, s/he should always act in a cooperative, calm way, i.e. have good social skills and team guiding capacity.

Each of the other team members will have a particular task, e.g. cook, camp keeper, tracker, navigator etc. They should be assigned with regard to their personal strengths and interests. Everybody should respect and follow the instruction of the team leader.

Problems and conflicts should be discussed in an open, friendly way without getting too emotional. It is helpful for the team to sit down in the evening after dinner, and hold a short meeting to review and wrap up the happenings of the day.

7.2 Respect of nature

We are not just responsible for the other team members, but also for the environment, which is affected by our behavior as well. Especially as conservationists we have to respect and protect our natural heritage – the plants and animals of our forests. There is a meaningful slogan getting it to the point:

"Leave nothing but your footprints, take nothing but your memories"

This should be our motto when we are carrying out biomonitoring operations. The following rules should be obeyed:

1. Be invisible!

The best chance to see animals we have if they don't notice our presence. Try to be as inconspicuous as possible. Avoid noise and always be quiet and calm, talking with a low voice. This is obligation during the surveys themselves, but also should be followed when in the camp. Wear inconspicuous clothes, especially

during survey work. Strictly no drugs alcohol during the whole field trip, and no smoking during surveys.

2. Respect plants!

Cut and destroy as less as possible!

We have to keep in mind that plants are also living organisms, and it takes a long time for trees to grow. Even thin trees with a small stem diameter might be already ten years or elder. Cutting a single liana stem may kill a large area of canopy above. So always think ahead before cutting vegetation – is it really necessary? The following guidelines will help you to make the right decision:

Transects: Transect lines should be as narrow as possible – no strips! This is not just essential for the distance sampling method, but also will avoid unnecessary destruction of vegetation, require less manpower and time. Moreover, opening wide, visible trails is dangerous also with regard to hunters – providing them general easy access, probably to areas where they have never been before.

Don't cut tree marks! Untrained transect cutters often cut big blaze marks on trees, which sometimes allow infections to be established, eventually causing the death of the tree.

Camp furniture: Only build what is really necessary, such as a shelter for the cooking place etc.. In case you should make regular use of the same camp, it is ok to build some constructions for convenience such as simple chairs, rack for drying clothes etc., but it also should also be kept at a minimum. Use only common and fast growing plant species.

3. Respect animals!

Don't kill or disturb any animals!

Your forest might be one of the last remaining refuge for wild, endangered animals. Certain animal species in Liberia are fully protected by law (see Chapter 1) and must not be killed – regardless where. Of course you will not hunt during the biomonitoring operations. Further don't disturb animals, e.g. by unnecessarily touching them, destroying their house etc.

4. No litter!

Remember our motto: *"Leave nothing but your footprints……."*!
Burn all waste, i.e. plastic, paper, food rests etc., including very small thing such as cigarette butts. But **NEVER burn batteries!** The material inside batteries is poisoned and will harm the environment. You should also protect yourself and never touch leaking batteries with the bare hand, but use some tissue or gloves. Used batteries have to be collected and carried out of the forest at the end of the survey. Empty tin cans should also burned, and then collected and carried out of the forest as well. Burning the cans will remove any odour of food and render them brittle, so they can easily be crushed. If finally leaving your camp, after packing look carefully around if no waste is left.

5. Protect water resources!

Do not use areas close to water resources (streamlets, creeks etc.) as rest room. Defecation (deposit of faeces) in or besides streams, rivers etc. are expressly forbidden. (All human faeces and any toilet paper should be buried ca. 50 cm deep in the forest).
Bathing, washing clothes etc. should always be downstream from where cooking and drinking water is taken.

6. Don't go to the forest / leave the forest if you are sick!

Anybody who feels ill should not go to the forest. In case somebody gets sick during fieldwork, he should at least stay at the camp, or, if possible leave the forest.

ANNEX 4B: TRAINING MANUAL MODULE 2

PROSPER

PEOPLE, RULES AND ORGANIZATIONS SUPPORTING THE PROTECTION OF ECOSYSTEM RESOURCES

BIOMONITORING HANDBOOK FOR COMMUNITY FORESTRY IN LIBERIA

ANNEX 4 B

TRAINING MANUAL MODULE 2

CONTENT

1. Species list and identification…….……... 1

2. Data recording methodology……..……... 7

2.1 General notes……..….. 7

2.2 Data collection sheet……..……. 8

3. Distance Sampling (optional add-on)……..…... 16

3.1 Overview…….…….. 16

3.2 Data collection sheet……..….17

3.3 How to use the range finder……..…….25

4. Important rules for accurate data collection……..... 28

1 Species list and identification

Biomonitoring is a useful tool to observe the status of biodiversity over time in a given area, for example in a community forest. It allows us to detect changes in animal and plant populations, human activities, and can help to identify possible threats, and therefore provides essential information for the forest management.
In order to get a broad overview of the whole ecosystem, biomonitoring is not focused on a single animal or plant species, but can be understood as a multi-species survey. However, if we monitor the transects, we cannot record **all** species, but have to be selective. For the purpose of a community forestry monitoring program, data collection along the transects will focus on two main data sets: (1) all kind of human impacts (including hunting, farming, mining, logging and harvesting of other forest products), and (2) a subset of certain animal species, which we call indicator species (explained below). The two data sets are considered most suitable both in view of their information value for the CF management units and practical aspects, as they can be relatively easily and accurately recorded. The protocol will further include basic phenological data, that is observations on fruiting and flowering trees along the transects, to better understand ecological factors such as variations in spatial distribution of the selected animal species. Threats to trees and other plants in the community forest, which are mostly caused by farming and timber extraction, and probably by overharvesting of (specific) forest products (such as rattan, bush pepper etc.) will be covered by the human impact monitoring. In case there is a site-specific need to monitor particular species, which are not included in the basic protocol, they can just be added to the list.

The animal species which should be monitored are selected based on the following criteria: species that are subject to human pressure (e.g. through hunting, habitat destruction and fragmentation), species of conservation concern (indicated by IUCN status, see below) and species that are easy to recognize, identify and monitor. Because these species indicate something (for example the intactness and quality of the forest, the hunting level etc.), we call them “Indicator Species”.

Indicator species
=
a biological species that defines a trait or characteristic of the environment

Examples:

- Big animals such as the Forest Elephant, Pygmy Hippo, Leopard, Chimpanzee etc. have large home ranges and depend on contiguous forest blocks, which fully include many other animals’ habitat needs. Their presence and density therefore indicate the degree of intactness or fragmentation of a forest.
- Big animals are highly vulnerable to hunting (as they provide a lot of meat compared to smaller species), and therefore indicate the hunting pressure.

- Large predators as the Leopard depend on medium-large sized prey, e.g. duikers and hogs, and therefore its presence/absence might allow inference with regard to the prey population.
- Certain species such as the Red Colobus, Diana Monkey or Black-casqued Hornbill depend on intact high forests and disappear with forest destruction.
- Duikers exploit the forest floor and therefore are a good indicator for forest intactness on the ground level. They further are vulnerable to both shotgun and snare wire hunting and therefore trends can indicate the level of hunting pressure.
- Crocodiles maintain structure and function in aquatic ecosystems, e.g. by selective predation on fish species, recycling of nutrients etc., hence provide information of the status of wetlands.

When choosing our indicator species we also have to consider how suitable they are to be monitored by line transect sampling. In other words: how easy?
Chimpanzees for example are relatively easy to survey. Though you might not often see them directly, you can hear them and find their signs such as nests and nut cracking sites. In contrast, a small animal such as a crab might tell you something about the water quality, but it is difficult to monitor.

Third we have to keep in mind that biomonitoring data are only meaningful, if they are accurate. Hence correct species identification is absolutely necessary and cannot be stressed enough. All efforts you put into the data collection will become useless if our species records are wrong. For example, the calls of the Blue-headed Wood Dove are easily confused with the one of the Tambourine Dove, and as most of the time you might rather hear than see it, a definite species identification will be impossible. So it would not make much sense to include one of these species in the biomonitoring list.

All these features mainly apply to large-medium sized mammals such as primates, ungulates (hoofed animals) and carnivores (animals that eat meat). The proposed basic biomonitoring protocol comprises 39 species (29 mammals, 8 birds and 2 reptiles, see Table 1 below), of which 11 by IUCN are classified as threatened (4 Endangered and 7 Vulnerable), and 9 as Near Threatened.

IUCN

What is IUCN?

IUCN stands for **I**nternational **U**nion for **C**onservation of **N**ature

- Founded in 1948 as the world's first global environmental organization
- Today the largest professional global conservation network and a leading authority on the environment and sustainable development

IUCN MEMBERSHIP

Total Number of Members:	**1,156**	
States	87	e.g. Liberia, represented by FDA
Government Agencies	117	
National NGOs	818	
Affiliates	33	
International NGOs	101	e.g. FFI

What does IUCN do?

Vision: "a just world that values and conserves nature"

- **Science** – IUCN develops and supports cutting-edge conservation science, particularly on biodiversity and ecosystems, e.g. through 11,000 experts setting global standards in their fields, for example, the definitive international standard for species extinction risk – the IUCN Red List of Threatened Species.
- **Action** – IUCN runs hundreds of conservation projects all over the world from the local level to those involving several countries, all aimed at the sustainable management of biodiversity and natural resources.
- **Influence** – through the collective strength of more than 1,000 government and non-governmental member organizations, IUCN influences international environmental conventions, policies and laws.
- **Empowerment** – IUCN helps implement laws, policy and best-practice by mobilizing organizations, providing resources and training, and monitoring results.

IUCN Red List of Threatened Species

The IUCN Red List of Threatened Species is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of animal and plant species. It plays a prominent role in guiding conservation activities of governments, NGOs and scientific institutions. The introduction in 1994 of a scientifically rigorous approach to determine risks of extinction that is applicable to all species, has become a world standard.

The goals of the IUCN Red List are to:

- Identify and document those species most in need of conservation attention if global extinction rates are to be reduced
- Provide a global index of the state of change of biodiversity

IUCN Red List Categories and Criteria (version 3.1; 2001):

There are nine categories for classifying the level of global extinction risk of animal and plant species. The nine categories are explained and listed below in descending order of risk. The allocation of a species to one of these categories is based on particular assessments within the following criteria (A-E):

A. Decreasing rates in population size
B. Geographic range
C. Population size of mature individuals and it's declining rate
D. Other special parameters of population size
E. Probability of extinction in the wild based on quantitative analysis

Categories:

EXTINCT (EX)

A species is *Extinct* when there is no reasonable doubt that the last individual has died (i.e exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual).

Example: Tasmanian Wolf (extinct since 1936)

EXTINCT IN THE WILD (EW)

A species is *Extinct in the Wild* when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.

Example: Scimitar Oryx

CRITICALLY ENDANGERED (CR)

A species is *Critically Endangered* when the best available evidence indicates that it meets any of the criteria A to E for *Critically Endangered**, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

*E.g. criteria A for *Critically Endangered*: Reduction of population size of more than 90% over the past 10 years; criteria B for *Critically Endangered:* geographic range estimated to be less than 100 km^2 and severely fragmented etc.

Example: Western Gorilla

ENDANGERED (EN)

A species is *Endangered* when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

Example: Pygmy Hippo, Jentink's Duiker, Chimpanzee, Red Colobus

VULNERABLE (VU)

A species is *Vulnerable* when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

Example: Zebra Duiker, Forest Elephant, Diana Monkey, Dwarf Crocodile etc.

NEAR THREATENED (NT)

A species is *Near Threatened* when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Example: Bongo, Yellow-casqued Hornbill, Leopard, Olive Colobus etc.

LEAST CONCERN (LC)

A species is *Least Concern* when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.

Example: Maxwell's Duiker, Red River Hog, Great Blue Turaco etc.

DATA DEFICIENT (DD)

A species is *Data Deficient* when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A species in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. *Data Deficient* is therefore not a category of threat. Listing of taxa in this category indicates that more information is required.

Example: Slender-snouted Crocodile

NOT EVALUATED (NE)

A species is *Not Evaluated* when it is has not yet been evaluated against the criteria.

Example: Giant Achatina Snail

Table 1. Faunal indicator species list.

The list serves as a general guideline for the species, which should be included in the biomonitoring program. The list however might need to be adjusted to site-specific criteria and priorities, by, for example, discarding some species which don't occur at the site and/or adding other species (including plants) of interest.

No.	English name	Scientific name	IUCN status
1	Chimpanzee	*Pan troglodytes verus*	EN
2	Black-and-White Colobus	*Colobus polykomos*	VU
3	Olive Colobus	*Procolobus verus*	NT
4	Red Colobus	*Procolobus badius badius*	EN
5	Campbell's Monkey	*Cercopithecus campbelli*	LC
6	Diana Monkey	*Cercopithecus diana diana*	VU
7	Spot-nosed Monkey	*Cercopithecus petaurista*	LC
8	Sooty Mangabey	*Cercocebus atys atys*	NT
9	Elephant	*Loxodonta africana cyclotis*	VU
10	Pygmy Hippopotamus	*Choeropsis liberiensis*	EN
11	Leopard	*Panthera pardus*	NT
12	Golden Cat	*Caracal aurata*	NT
13	Bongo	*Tragelaphus eurycerus*	NT
14	Buffalo	*Syncerus caffer nanus*	LC
15	Bushbuck	*Tragelaphus scriptus*	LC
16	Jentink's Duiker	*Cephalophus jentinki*	EN
17	Yellow-backed Duiker	*Cephalophus silvicultor*	LC
18	Zebra Duiker	*Cephalophus zebra*	VU
19	Maxwell's Duiker	*Philantomba maxwellii*	LC
20	Black Duiker	*Cephalophus niger*	LC
21	Bay Duiker	*Cephalophus dorsalis*	LC
22	Ogilby's Duiker	*Cephalophus ogilbyi brookei*	VU
23	Royal Antelope	*Neotragus pygmaeus*	LC
24	Water Chevrotain	*Hyemoschus aquaticus*	LC
25	Red River Hog	*Potamochoerus porcus*	LC
26	Giant Forest Hog	*Hylochoerus meinertzhageni*	LC
27	Giant Pangolin	*Smutsia gigantea*	NT
28	Long-tailed Pangolin	*Uromanis tetradactyla*	LC
29	Tree Pangolin	*Phataginus tricuspis*	NT
30	Black-casqued Hornbill	*Ceratogymna atrata*	LC
31	Yellow-casqued Hornbill	*Ceratogymna elata*	NT
32	White-crested Hornbill	*Tropicranus albocristatus*	LC
33	Brown-cheeked Hornbill	*Bycanistes cylindricus*	NT
34	African Pied Hornbill	*Tockus semifasciatus*	LC
35	Piping Hornbill	*Bycanistes fistulator*	LC
36	White-breasted Guineafowl	*Agelastes meleagrides*	VU
37	Great Blue Turaco	*Corythaeola cristata*	LC
38	Dwarf Crocodile	*Osteolaemus tetraspis*	VU
39	Slender-snouted Crocodile	*Mecistops cataphractus*	DD
	etc		

2 Data recording methodology

2.1 General notes

- Biomonitoring will take place once or twice a year along the established transects.
- The data collection will take place in the dry season, between November and March. If time, budget and data management allow, a second data collection phase will be carried out in the wet season.
- Each transect line will be monitored one time per biomonitoring phase.
- In order to get reliable and comparable data, it is important that always the same persons do the data collection.
- Each transect line will be monitored one time during a day survey. It should be possible to complete one transect in one day.
- Choose the transect line that you want to survey at least one day in advance.
- Four persons per team will carry out the data collection, while 2 stay in the camp for cooking and security. Two of the data collectors should focus on signs on the ground, such as tracks and dung, while the other two should observe the canopy, looking for birds, monkeys, and in particular for chimpanzee nests. They should carry binoculars.
- The survey team will leave the camp early in the morning. For reasons of visibility, it is best to carry out the data collection between 07:30 am in the morning and 04:00 pm in the afternoon.
- The survey should not be done when it is raining. If it starts raining while you are already on the transect, you will have to stop and continue after rain.
- Usually a transect is surveyed from the starting point (0m) to the end (for example 2,000m). However, if it is easier to reach the ending point from the camp, you can also start from the end. You will have to make a note on the survey direction on the data collection sheet (see below).
- Begin your observations at point 0m (or the ending point) and fill the data recording sheet, which is explained in detail below.
- Every part of the transect line must be surveyed. Sometimes the line will lead through Uapaca roots or across a big rock, but as long as you don't have an insurmountable object (for example such as a huge Ekki tree) you have to follow the line. Do not take detours because it's more convenient!
- No signs should be missed. Take time and walk the transect slowly, and stop to listen for animals regularly (e.g. every 50m). Search carefully for animals and signs on the ground and in the canopy, to make sure that you don't miss anything. Pay attention especially to the following situations:
  - Objects directly above your head are easily missed, so the 2 trackers focusing on the canopy must check regularly the area directly above them
  - Walking uphill/downhill: When you walk uphill your view and eye-level is more focused on the ground and you might easily miss objects in the canopy. When

you walk downhill your view and eye-level is more focused on the canopy and therefore you might easily miss objects on the ground. So all trackers should regularly turn around and look back in order to check the whole range of vision.

- Do not leave the line to follow animals or to see signs beyond your view. All observations must be visible from the transect line. Leaving the trail violates the assumptions of transect sampling and may alter the results. Once you have made an observation from the line, it is of course allowed to leave the line to make accurate recordings (e.g. you see a chimpanzee nest from the line, you then leave the line to make your recordings).
- Do not smoke or talk loudly while walking transects.

2.2 Data Collection Sheet

CF Site: BIOMONITORING DATA COLLECTION SHEET Month/Year:

Date:			**Start Point:**	**Weather data - take records every hour** use one of the following numbers for clouds, rain and wind: 0, 1, 2 or 3 (0=none, 1=small, 2=medium, 3=heavy)										
Transect No:			**Start Time:**	**Time:**										
Team:			**End Time:**	**Clouds:**										
Data recorder:			**Number of sheets:**	**Rain:**										
				Wind:										

No.	Time	Meter	Species	Type of sign	Number ind / nests	Age of sign	Remarks

<u>Headlines</u>

CF Site: *self-explaining* (for example Sayee CF)

Month/Year: *self-explaining* (for example 03/2014 if monitoring takes place in March 2014)

Date: *self-explaining* (Day/Month/Year)

Transect No.: *self-explaining* (for example T04)

Team: if there are several Field Teams in one CF site, indicate which Team (for example Team 1)

Data Recorder: name of person who is filling the data sheet

Start Point: 0m or 2000m (in case transect length is 2 km)

Start Time: the time when you start the survey at the start point

End Time: the time when you reach the end point and the survey is finished

Number of sheets: in case you fill more than one sheet for data recording along one transect, at the end of the survey write down how many sheets you have used

Weather data: record the weather conditions at the start time and then every full hour. Choose one of the following numbers (0-3) to describe clouds, rain and wind:

	Clouds	**Rain**	**Wind**
0	no clouds, sky clear	no rain	no wind, calm
1	lightly overcast	light rain	breeze
2	medium overcast	medium rain	more windy
3	heavily overcast	heavy rain	storm

Columns

No.: Every observation you make along the transect will get a number. Start with 1 and then continue with 2, 3, 4, 5,…… etc.

Observation refers to a single species encounter, i.e. **either** signs of one of the listed animal species **or** signs of humans **or** fruits/flowers (see below under the explanation of **Species**). You have to make sure that you *don't give different or more numbers to the same observation*.

For example, the first observation you make along your transect is that you see a group of Diana Monkeys. You will start filling your sheet with No. 1 and then fill all the other rows related to this observation (i.e. time, meter etc.). Let's assume the Diana Monkeys flee away from you, into the same direction as your transect line is running. If you encounter Diana Monkeys again after 50 m, you should not record them again, because you can be pretty sure that it is the same group which you have already recorded. So make sure that you don't record the same individuals several times on your data sheet.

If for another example you encounter Diana Monkeys and Campbell's Monkeys together at the same time, then every species gets its own number (e.g. No. 1 Diana Monkeys, No. 2 Campbell's Monkeys).

Time: Note the time of your observation (hour:minutes)

Meter: Note where on the transect line you are. Use the number of the nearest 50m mark. For example if you find some tracks at 1,790m, your nearest mark would be 1,800m.

Species: This column refers to one of the following observations:

(1) One of the indicator animal species on the biomonitoring list (see Table 1 above): fill in the English name

(2) Human signs: fill in "Human"

(3) Fruits or flowers: in case you find fruiting or flowering trees along the transect, fill in the name of the tree; if possible the English or Scientific name, if not then fill in the local name

Type of sign: Use the following abbreviations (this is just a guidance and flexible; other codes could be used if more convenient, but make sure to use distinct and unique codes for each sign; likewise, additional signs could be included where necessary)

SEE for see: you see the animal or a human

HEA for hear: you hear an animal or human voices

TRA for tracks: animal or human footprints

DUN for dung

NES for chimpanzee nests

NCS for chimpanzee nut cracking sites

ROA for roads: elephant road, hunting road

CAM for (hunting) camps

FAR for farms

GUN for gun (in case you find a gun, but don't see anybody)

GUS for gun shot (you hear a gun shot)

HAR in case people were harvesting any forest product (for example a piece of bark, or cut a stick to harvest fruits or rattan etc. Specify the plant species and part that was harvested in the last column "Remarks")

SHE for gun shells

WIR for trap wires (snare traps)

FRU for fruits

FLO for flowers

OTH for any other sign (for example burrows, feathers, eggs, bones, fishing nets etc.; specify in the "Remark" column)

Note: In case you find more than one type of sign, you should only record <u>one of it in this column</u>, but make a remark of the other signs in the last column (**Remarks**). For example, if you find fresh duiker dung, you will most probably also see the footprints. Or if you find a fresh elephant road, you will also see footprints. Or if you see monkeys some of them will also shout. To help you making a decision which of the signs you should fill in the column **Type of sign**:

- *See is more important than hear or tracks*
- *Dung is more important than tracks*

- *Chimpanzee nests are more important than their dung or tracks*

So for example, if you find elephant dung and footprints, here you fill in **DUN** (for dung), and in the column **Remarks** you note dung and tracks

Number of individuals/nests:

The number you have to enter here depends on your type of sign:

See: How many animals / humans do you see? In case you cannot count all, give an estimate (e.g. you encounter a group of monkeys and can see 3 individuals, but you know there must be at least 5, fill in 5).

Hear: How many individuals do you hear calling or talking? **Do not** count the number of calls themselves. Again, if it is difficult to count the individuals try to estimate their number (e.g. if a group of Red Colobus is vocalizing, it will be difficult to distinguish the individuals)

Tracks: The tracks you see come from how many individuals? **Do not** count the number of footprints.

Dung: The dung you see was produced by how many individuals? **Do not** count the number of dung pellets.

Nests: If you see chimpanzee nests, it is important and allowed that you leave the transect line to make sure that you can find and count all of them. Chimpanzees live in groups, and the number of nests can give us an idea of their group size. Sometimes it is not possible to see <u>all</u> nests of one group from the transect line. So in this special case, as soon as you can see one or a few nest from your transect line, it is allowed to leave the transect line to find more. Fill in the number of all the nest you could find.

Gun: How many guns do you find?

Gun sound: How many gun shots do you hear?

Gun shells: If you find empty gun shells, count them and **<u>also collect</u>** them

Wire: How many trap wires? Count and **<u>collect</u>** them

Fruits: How many fruits do you count? If there are too many (e.g. more than 50) so that it will take too much time to count them, just enter an estimate, based on 50-scaled intervals (i.e. 100, 150, 200 etc.)

Flowers: How many flowers do you count? If there are too many (e.g. more than 50) so that it will take too much time to count them, just enter an estimate, based on 50-scaled intervals (i.e. 100, 150, 200 etc.)

Age of sign: We estimate how fresh or old signs are in case of

(1) Dung
(2) Chimpanzee nests and nut cracking sites
(3) Tracks
(4) Roads
(5) Camps
(6) Farms
(7) Gun shells
(8) Wires
(9) Fruits
(10) Flowers

We will use the codes 1 - 4 for the classification of all signs, but these numbers will have a special meaning depending on the type of sign (see Table 2 below). This is necessary because there are international standards, especially in the case of elephant dung and chimpanzee nests. It is important to use the same codes to make sure that data are comparable with data from other biomonitoring programs.

It is therefore crucial that <u>before</u> you allocate an age number to your observation, you check the table and decide, which description is the right one for the age of your sign.

Remarks: Here you will record additional notes, such as

- If you have more than 1 type of sign of the same observation, you make a note on the second type here (for example you find elephant dung and footprints, you will enter **DUN** in the column "Type of sign" and Tracks in the Column "Remarks")
- **FAR**m: If you encounter a farm, add some notes on its use (what kind of crops are/were grown) and extent, for example estimate the size and / or by how many people it is/was used
- **HAR**vesting signs: specify the plant species and the pieces that were harvested. Note also if the plant has been "killed" (its stem totally cut through)
- "Other" signs: if you have entered **OTH** for "Other" in the Column "Type of sign" make a note here what kind of sign it is (e.g. feathers, eggs etc.)
- Any other important notes you need to add to your observation

Table 2. Age Classification of Signs

Sign	Age class			
	1	2	3	4
Elephant dung	All balls are intact	One or more balls (but not all) are intact	No balls are intact, but there is still dung material left and sticking together (e.g. plant fibres are hold together by dung material)	No dung material is left, only traces such as plant fibres remain
Other dung	Fresh - sometimes still warm, smell and a sheen (from fatty acids) still present	Recent - Smell might still be present, but no sheen anymore, overall form still intact, no mould	Old - no smell, may have mould, overall form breaking down	Very old - crumbling, dispersed, tending to disappear, covered by leaf fall
Chimp Nests	Fresh - all leaves are green and generally dung or urine smell is found under the nest	Recent - most leaves are still green, but also drying leaves of different colours present, no dung or urine smell under the nest	Old - most leaves dry/brown, but the form of the nest is still largely intact	Very old - no or only few leaves left, nest has lost its main form, but is still identifiable by remaining twigs
Chimp Nut cracking site	Fresh – less than a week	Recent – less than 1 month but more than 1 week	Old – between 1 and 6 months	Very old – more than 6 months
Tracks	Fresh - less than 1 day	Recent - less than 1 week (but more than 1 day)	Old - less than 1 month (but more than 1 week)	Very old - more than 1 month
Elephant Road	Used during the past few days	Recently used - not during the past few days, but within the last month	Old - not used for more than 1 month	Very old - not used for more than 6 months
Hunting Road	Fresh - very fresh cuttings present	Recently used (e.g. during the last week)	Old - not in use for more than 1 month	Very old - not in use for more than 6 months
Camps	In use	Abandoned, but recently used	Old - not in use for more than 1 month, but structures (i.e. sticks for tent etc) still present	Very old - structures rotten or not present anymore
Farms	In use	Recent – used during the latest farming season	Old – more than 1 year or 2 seasons ago	Very old – more than 5 years ago
Gun Shell	Fresh (between 1 day and 1 week)	Recent (between 1 week and 1 month)	Old (more than 1 month)	Very old (more than 6 months)
Wire	Fresh (between 1 day and 1 week)	Recent (between 1 week and 1 month)	Old (more than 1 month)	Very old (more than 6 months)
Fruits	Most fruits are unripe	Most fruits are ripe, but not fermenting yet	Most fruits started fermenting	Most fruits rotten
Flowers	Most flowers fresh	Most flowers in a initial stage of wilt	Most flowers shrivelled	Most flowers rotten

When you have reached the ending point and completed the monitoring of a transect line, enter the end time and number of sheets in the respective cells of the data collection sheet. Store the data sheet in a plastic map (clear bag) to protect it from rain or any other damage. On the way back to the camp, the data collection team has to maintain the transect line properly where necessary, for example clear re-growing vegetation, cut fallen sticks which are blocking the line etc. This should **not** be done during the data collection (only the most necessary clearing to allow movement of the team), as it might cause noise and distract recorders from observations. After each field trip the data collection sheets should be handed over to the Field Assistant.

The filled sheet below shows an example of how to fill the data recording sheet for the following scenario:

CF Site: Kortor CF — BIOMONITORING DATA COLLECTION SHEET — Month/Year: 03/2014

Date: 28/03/2014	**Start Point:** 0m
Transect No: T14	**Start Time:** 07:52
Team: John, Joe, Tim, Prince	**End Time:**
Data Recorder: John Darwin	**Number of sheets:**

Weather data - take records every hour
use one of the following numbers for clouds, rain and wind: 0, 1, 2 or 3 (0=none, 1=small, 2=medium, 3=heavy)

Time:	07:52	9:00	10:00	11:00	12:00	13:00				
Clouds:	2	2	2	2	1	1				
Rain:	0	0	1	0	0	0				
Wind:	1	1	1	1	1	0				

No.	Time	Meter	Species	Type of sign	Number ind / nests	Age of sign	Remarks
1	07:58	0	Black-casqued Hornbill	HEA	1	-	
2	08:18	150	Maxwell's Duiker	SEE	1	-	
3	08:56	200	Bay Duiker	TRA	1	2	
4	09:24	400	Maxwell's Duiker	TRA	2	1	
5	10:15	550	Chimpanzee	NES	3	1, 2	and dung age 2 below one nest
6	11:08	600	Bay Duiker	DUN	1	3	
7	11:20	650	White-crested Hornbill	HEA	1	-	
8	11:44	800	Elephant	DUN	5	2, 3	and tracks, roads and feeding signs
9	12:30	1000	Human	SHE	1	2	
10	13:27	1150	Diana Monkey	SEE	7	-	
11	13:27	1150	Red Colobus Monkey	SEE	5	-	

- On the 28th of March 2014, the four trackers of the Kortor CF Field Team carry out the biomonitoring data collection along Transect No. 14 in the Kortor CF. John Darwin is the Team Leader and also responsible for the data recording.
- They start the survey from the starting point at 07:52.
- Before starting observations they record the weather data (medium overcasts, no rain, breeze), and repeat this every full hour.
- At 07:58, they are still close to the starting point, they hear a Black-casqued Hornbill.
- At 08:18, at approximately the 150m mark, they see a Maxwell Duiker on the left side of the transect.
- At 08:56, around the 200m-mark, they find tracks of one Bay Duiker. The animal passed this area recently, that is more than 1 day but less than 1 week. Tim reminds everybody not to forget the weather data recording at 9:00am.
- At 09:24, they find fresh tracks of 2 Maxwell's Duikers. They check for the nearest 50m-mark which is 400m.
- At 10:15 the trackers encounter a fresh chimpanzee nest, not far from the 550m mark. Under the nest they find some dung of age class 2, so John makes a note on that in

the “Remarks” column. They carefully check the surrounding area and discover two more nests, one also age class 1, and another one of age class 2.

- At 11:08 they find Bay Duiker dung, of one individual and age class 3. The nearest mark is the 600m sign.
- A few minutes later, at 11:20, close to 650m, they hear a White-crested Hornbill.
- The next observation along the transect is elephant dung between the 800m and 850m mark, at 11:44. Obviously it was a group, who was feeding in the area. In total the trackers find dung of 5 different individuals and several other signs such as tracks, feeding signs, and roads. These additional observations are entered in the column “Remarks”. The consistence of the dung is classified as either age class 2 or 3.
- At 12:30 at around 1000m, the field team finds an empty gunshell. They think it was fired between one week and one month ago, and rate its age as class 2.
- At 13:27, at approximately 1,150 meter transect length, the team sees a group of Diana Monkeys, mixed with Red Colobus Monkeys. Since the monkeys get alert and flee, the team does not have much time to observe and count the animals. They count at least 7 Diana Monkeys, and 5 Red Colobus Monkeys.
- etc.

3 Distance Sampling (optional in addition to the basic protocol)

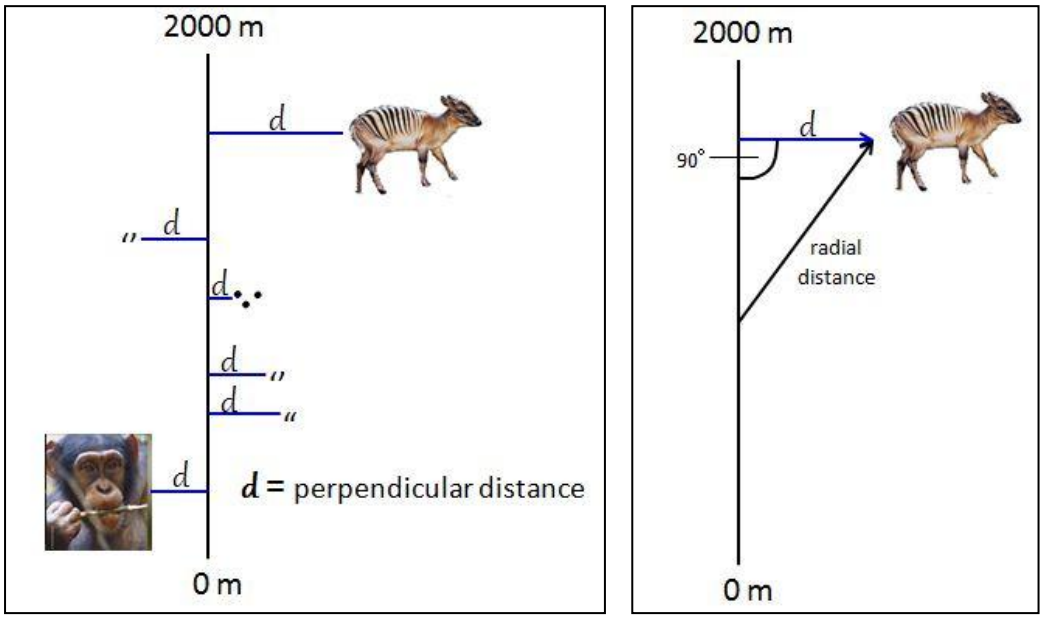
3.1 Overview

Distance Sampling is the same as Line Transect Sampling, but which, in addition to just recording the presence of animal signs, requires the exact distance measurements of the signs in relation to the transect line. If accurately recorded, the data will allow calculating population densities of selected animal species, by using the computer program DISTANCE. Not all animal signs of the protocol, however, can be used for this analysis, but only direct observations, dung and chimpanzee nests.

Direct observations (that means that the respective animal species is seen) don't require any further ancillary information and can be analysed directly by DISTANCE. In case of indirect signs such as dung and chimpanzee nests, one will need additional information on the production and decay rate of these signs. This would either require additional studies, which most often are not feasible, or references from the literature have to be taken. These are mainly available for chimpanzee nests and elephant dung, while information on other species, for example on duiker dung production and decay rates, is scarce or lacking. These factors need to be carefully considered when deciding if a CF site is suitable for, and which species should be included in the Distance Sampling protocol.

The following explanations generally refer to all direct observations, all dung and chimpanzee nests. Two aspects need particular attention when filling the data sheet:

1. For DISTANCE it is crucial to distinguish between a *single observation* and a *clustered observation*. A single observation refers to one individual, for example one sees <u>one</u> Bay Duiker or finds dung of <u>one</u> elephant. However, some animals like chimpanzees, monkeys and elephants live in groups, so it is very likely that at a certain spot one finds not only signs of one individual but of more individuals of the same species. This is called a clustered observation. For example if you find a chimpanzee nest, it is very likely that there are more in the vicinity. In the data sheet, this will be indicated by the "No." as explained below.
2. Accurate distance measurement is vital and the linchpin for the data analysis. Distance Sampling requires the **perpendicular distance**, which is the shortest distance between the transect line and the sign (see figure below). For better illustration the right part of the figure shows the difference between the perpendicular distance ("d", = the upper, straight short line) and the radial distance (the lower, longer diagonal line). Both measurements express the distance of the Zebra Duiker from the transect line, but the perpendicular distance is shorter than the radial distance. The angle between the perpendicular distance line and the transect line is always 90º. The perpendicular distances have to be measured <u>accurately</u>, and not just estimated. Use a tape measure and/or a rangefinder (explained in section 3.3). It is further important that measurements of signs close to the line are made precisely. A common error of inexperienced observers is to record all distances nearby the transect (e.g. within 50 cm) as 0 m. This is wrong and can have a very strong negative impact on the accuracy of density estimates. More details will be outlined in the respective section below.



Principle of Distance Sampling and the perpendicular distance

3.2 Data Collection Sheet

The data collection sheet for Distance Sampling has to be filled **in addition** to the basic data sheet that was explained in section 2.2. It cannot replace the basic protocol sheet!

CF Site: DISTANCE SAMPLING DATA SHEET Data Recorder:

Date:	Transect No:	Start Point:	Start Time:	End Time:

Fill this sheet for all direct encounters, dung and chimpanzee nests.
In case of clustered observations fill one row for each individual, but give all the same No.

No.	Time	Meter	Species	Type of sign	Distance (m, cm)	Age of sign	Group size	Remarks

<u>Headlines</u>

CF Site: *self-explaining* (for example Sayee CF)

Data Recorder: name of person who is measuring and filling the data sheet

Date: *self-explaining* (Day/Month/Year)

Transect No.: *self-explaining* (for example T04)

Start Point: 0m or 2,000m (in case transect length is 2 km)

Start Time: the time when you start the survey at the start point

End Time: the time when you reach the end point and the survey is finished

<u>Columns</u>

No.: Every observation will get a number. Observation refers to species level; start with 1 and then continue with 2, 3, 4, 5,…… etc. Other than in the basic protocol however, which does not further specify clustered observations, in this data sheet all individuals of a clustered observation will be listed separately, i.e. one row per individual, **where distance measurement is possible** (see below). To indicate that they all belong to the same observation, all will receive the same number **No.**. For example, along your transect you first see a Maxwell's Duiker, and later you find 3 chimpanzee nests, which obviously belonged to one group, next you will find Bay Duiker dung of one individual and the fourth observation along the transect is dung of 5 elephants etc. The numbering would be as shown in the example shown on page 24. The individual listing is important because in Distance Sampling we are interested in the distance of the signs, and the more data sets, the better. If for example you encounter a group of three chimpanzee nests, they most probably will be at different locations and thus at different distances from the transect line. Hence the individual listing is indicated in all cases you can do accurate counts of individuals and measurements, which will mainly be the case for indirect signs (as they are stationary), and for direct encounters of single individuals (since even if the animal moves you can remember where you first saw it and take the measurement to that point). In case of group encounters, e.g. a group of monkeys, however, it most of the time will not be possible to count all individuals, not to speak of accurate measurements, as the animals will move. And again, since precise data recording is vital for DISTANCE, these data must not be estimated. So in case of group encounters, observers are advised to identify the (hypothetic) center of the group and record only one distance, i.e. the perpendicular distance from the line to the group center (see also explanation of measurements further below). Hence, for (uncountable) group encounters, there will also be only one record in the data sheet (see example on page 24, observations No. 5 and 6).

Time: Note the time of your observation (hour:minutes).

Meter: Note where on the transect line you are. Use the number of the nearest 50m mark. For example if you find some tracks at 1,790m, your nearest mark would be 1,800m.

Species: Animal species, fill in the English name (see faunal indicator list Table 1 in Chapter 1 above)

Type of sign: It can only be either see, dung or nest. Use the following abbreviations:

SEE for see; **DUN** for dung and **NES** for chimpanzee nests

Distance (m, cm): Perpendicular distance of an animal, dung or chimpanzee nest from the transect line. The perpendicular distances have to be measured accurately, by using a tape measure or, for larger distances or in case of inaccessible areas, by a range finder (explained in section 3.3). Use the metric system and record them in meter and centimeter.

Metric system

The metric system is an international standardized system of measurement, which today is used in nearly every country in the world. The basic unit of length is the meter. One meter (1 m) is the same as 100 centimeter (100 cm), and 1000 meter is the same as 1 kilometer (1 km):

1 meter = 100 centimeter

1,000 meter = 1 kilometer

To give you an idea of these units:

- *1 vita cube is approximately 3 cm in length*
- *1 step of an adult human is approximately 1 meter in length*
- *Our transects are 2 km in length*
- *In a rainforest you hardly can see farther than 30 – 50 m*

It is also important to understand the decimal system, which refers to measurements which lie between the whole numbers and are indicated with a comma or dot:

50 cm = half a meter, we express this as **0.50 m**

130 cm = **1.30 m**

10 cm = **0.10 m**

1.80 m = 180 cm

5.40 m = 540 cm

2,500 m = **2.5 km**

500 m = **0.5 km**

0.7 km = 700 m

3.3 km = 3,300 m

The measurements we will take along our transect will be mainly in centimeter (e.g. signs close to the transect line, such as dung), and meter (e.g. a group of monkeys in the trees). For short distances such as some centimeter up to a few meters, we will use the tape measure. For longer distances we use the range finder.

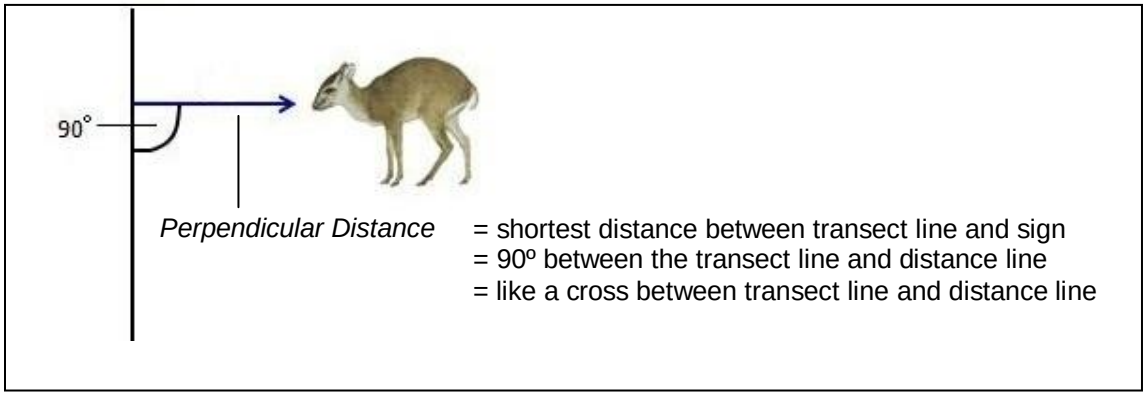
General notes on the measurements

- All measurements must be recorded as exact as possible. If you use the tape measure, the distance should be recorded to the nearest centimeter (e.g. 45 cm, 1.58 m; 8.65 m etc.). If you use the range finder, the distance must be recorded exactly as shown on the display.
- Perpendicular distances are measured from the **center** of the transect line. Sight along the transect and estimate where the center line lies. Imagine it as a very thin line indicating the exact center of the cut passage.
- Next identify the point on this imaginary center line from which the **perpendicular** distance should be measured. It might be necessary that you first will have to move along your transect line in order to reach the position from where you can measure the

perpendicular distance. To find this point stretch out your arms and move along the transect line until your arms point exactly in a straight line towards the sign.

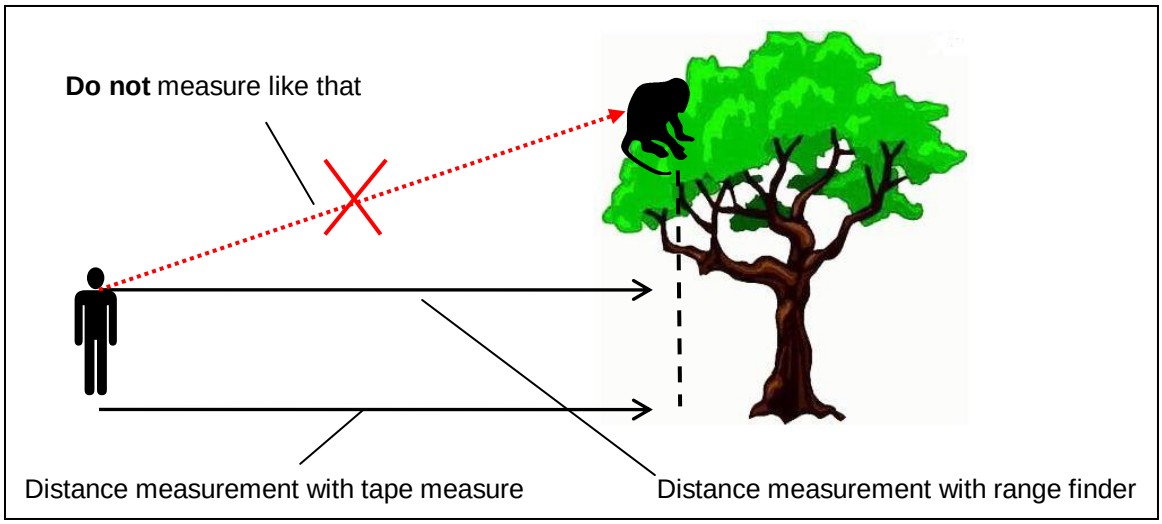
Measurement of direct observations (SEE)

- If you see an animal, remember the place where you saw it first, because it might run away. You then measure the perpendicular distance from the transect line to the place where you saw it first (see figure below). It might be necessary that you first will have to move along your transect line in order to reach the position from where you can measure the perpendicular distance.



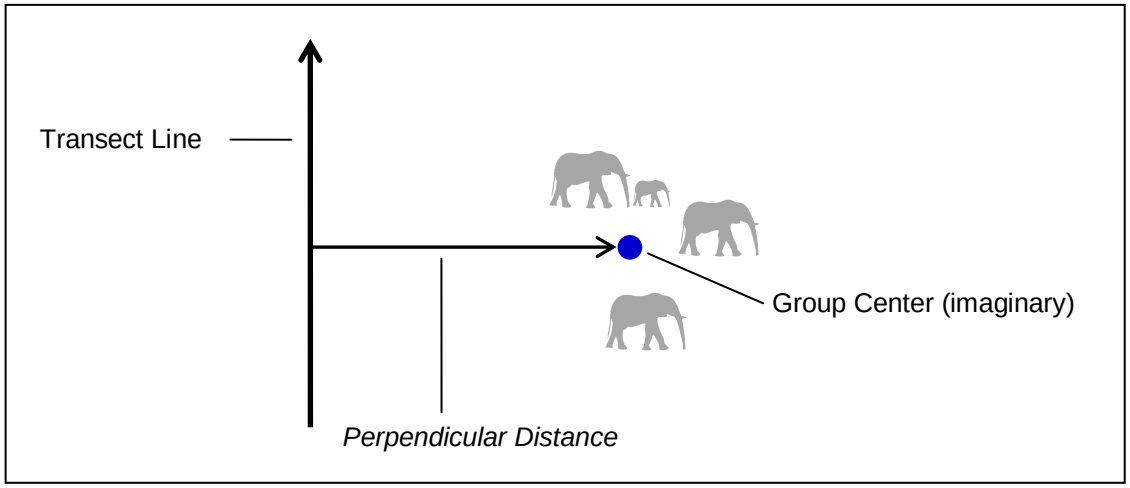
Example for measurement of direct observations

- It is also important that the measurement is leveled and not inclined or slanting. It means that if you use the tape measure you will measure the distance on the ground level, and if you use the range finder you will measure the distance on eye level (see figure below). If the animal sits on a high tree then you have to imagine a straight line from its position to the ground and measure the distance to this imaginary line.



Example for measurement of direct observations higher than eye-level

- If you see more than one individual, for example a group of elephants, then you have to determine the **imaginary center of the group** and measure the perpendicular distance to this imaginary center point.

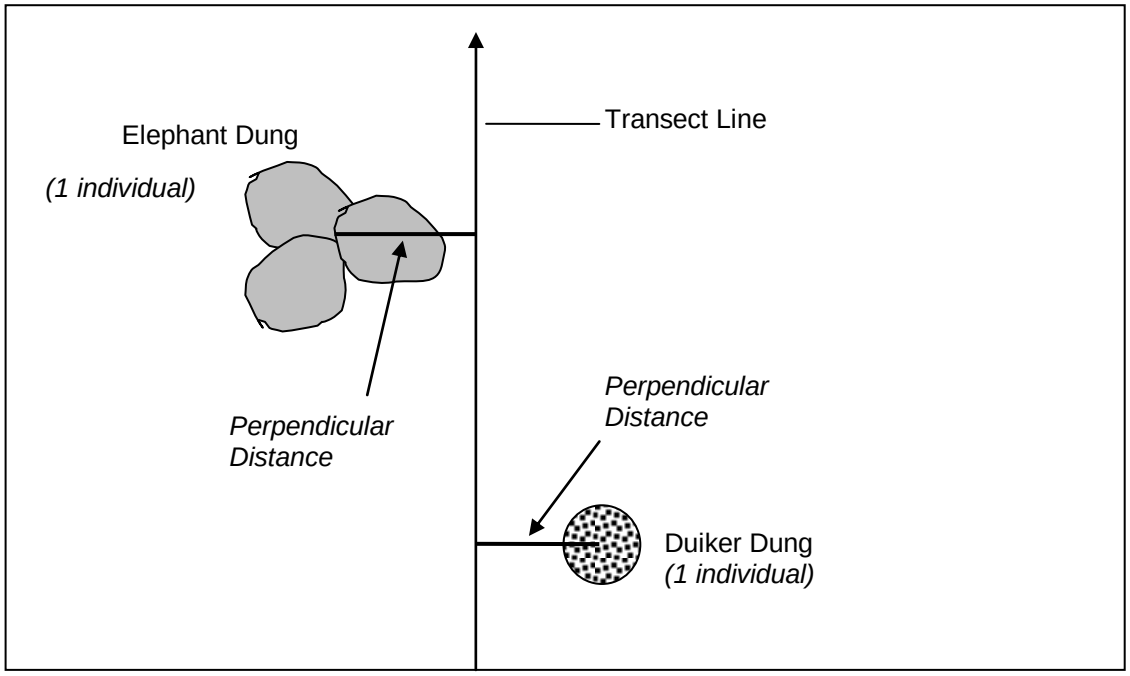


Example for measurement if a group of animals is encountered

Measurement of dung (DUN)

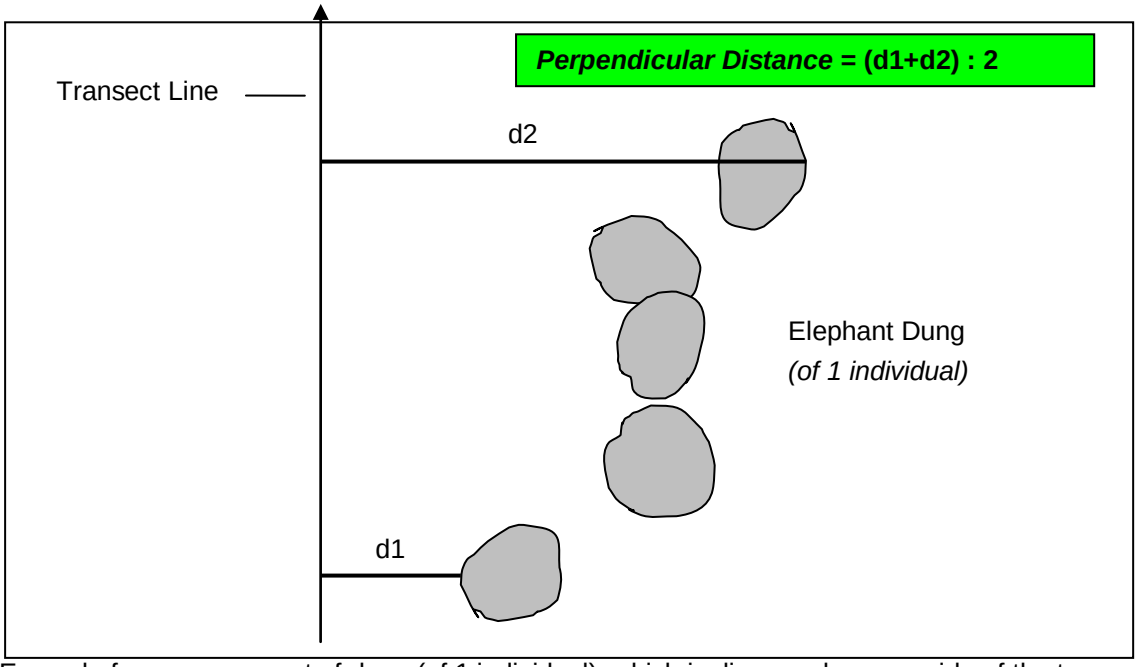
There are three main cases you will encounter when you have to measure the distance of dung:

a) The dung pellets (of 1 individual) form one cluster. Take the perpendicular measurement from the transect line to the <u>center</u> of this cluster:



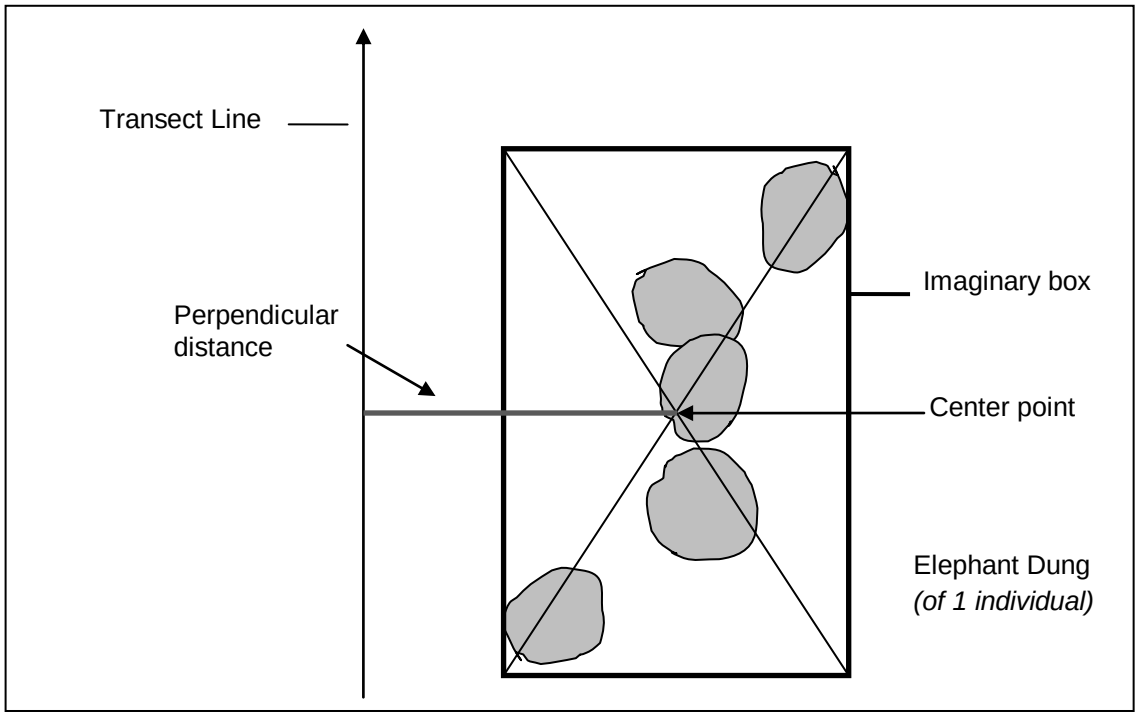
Example for measurement of dung, which forms one cluster

b) The dung (of 1 individual) is dispersed. This might for example be the case for elephant dung. Elephants often defecate whilst moving, so the single boli (= dung balls) might be spread over several meters. Search carefully in order to make sure that you find all balls. Then take the measurement of the edges of the nearest (d1) and furthest boli (d2), add both distances and divide the sum by 2. The result is the perpendicular distance, which you have to enter in your data sheet.



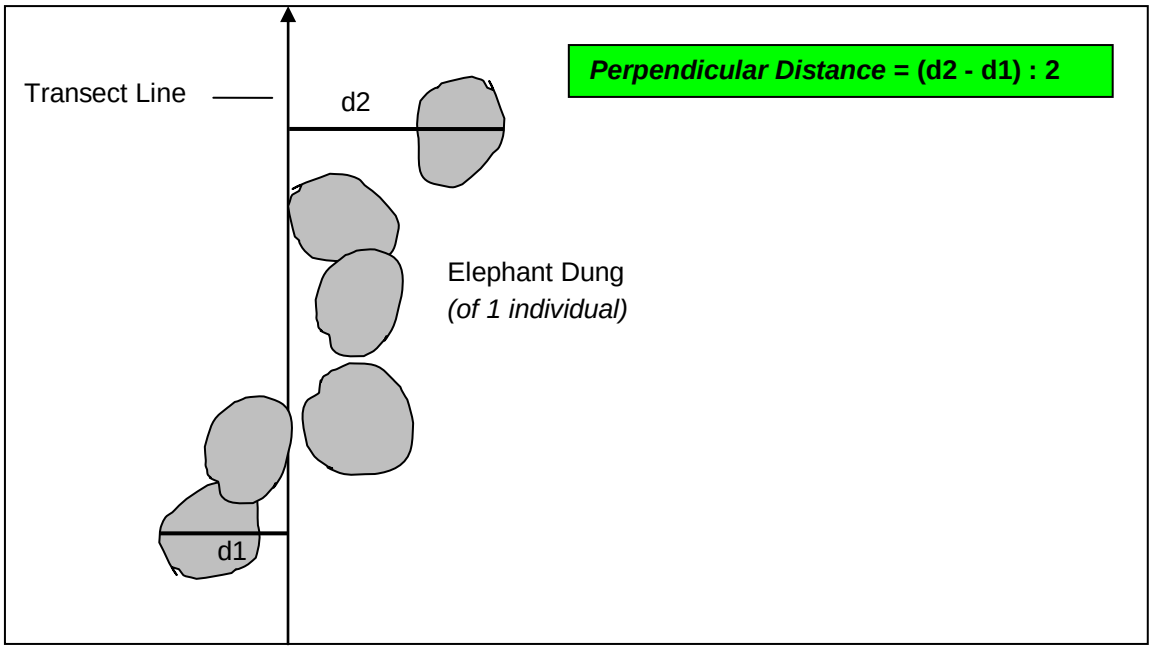
Example for measurement of dung (of 1 individual), which is dispersed on one side of the transect line

An easier way to ascertain the perpendicular distance without calculation is to draw an imaginary box around the outermost boundary of the whole dung spot and determine the center point, which is the intersection of the diagonals:



Measurement of the perpendicular distance to the center point of an imaginary box around the dung balls

c) The dung (of 1 individual) is dispersed across **both** sides of the transect. In this case you have to measure the furthest edges on both sides of the transect (d1 and d2), subtract the smaller value from the larger value (in this example d2-d1) and divide the difference by 2. The result is the perpendicular distance you have to enter in your data sheet. An easier way is to draw an imaginary box and determine the center point as illustrated above.

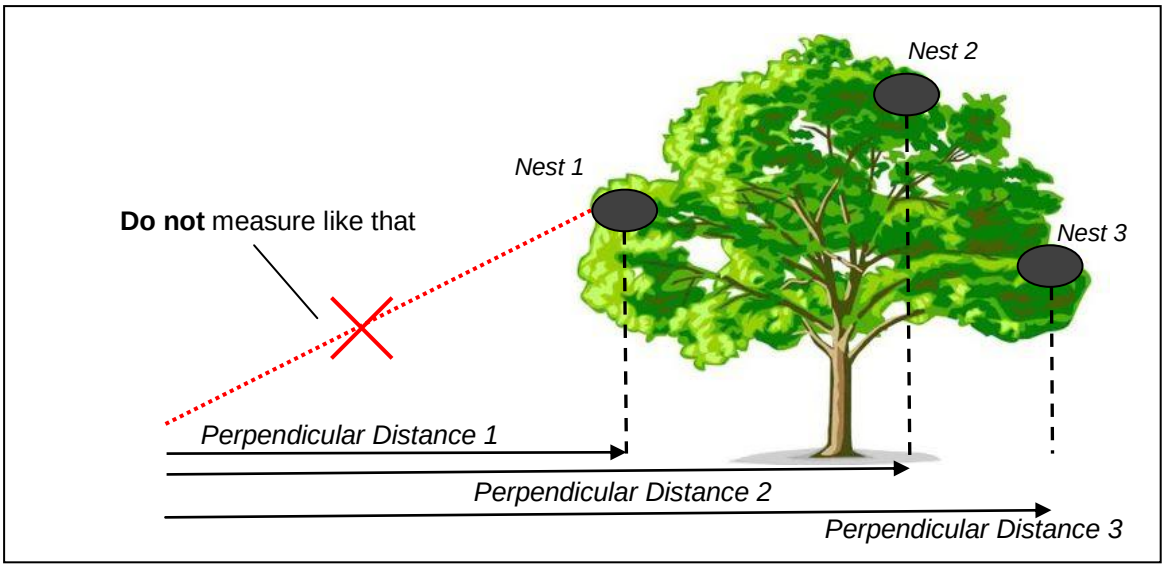


Example for measurement of dung (of 1 individual), which is dispersed across the transect line

In case you have dung of **more than one** individual, repeat the measurement as explained for all individuals separately, and fill one row per individual.

Measurement of chimpanzee nests (NES)

Chimpanzees usually build their nests in trees. As already explained it is important to take a leveled (straight) measurement and not an inclined one (as indicated by the dotted line in the figure below). The perpendicular distance of one nest is measured to the position on the ground that is directly under the center of the nest.



Example for measurement of a cluster of chimpanzee nests.

As chimpanzee live in groups, usually if you find one nest, there must be more. It is important that you find **all** nests of the group, so in this special case it is allowed to leave the transect line and search for the other nests. Measure the distance of every single nest and fill one row per nest in the data sheet.

Age of sign: Determine the age of dung and nests, by using one of the four age classes as explained in Table 2, section 2.2. **Do not** classify them just following your own idea, for example as fresh or old, but carefully read the definition and then use the correct classification. This is essential, because there are international standards, especially in the case of elephant dung and chimpanzee nests. It is important to use the same codes to make sure that data are comparable with data from other biomonitoring programs.

Group size: If you have a clustered observation, enter the total number of individuals. For example, if you encounter three chimpanzee nests, in each row of the individual nests you enter "3" in the "Group size" column. If you encounter dung of 5 elephants, enter "5" in the respective cells. This serves, mainly for indirect signs, as cross-check if you have recorded <u>all</u> individuals, since the number of individual rows of one clustered observation must correspond to the number you enter in the "Group size" column.
In case you encounter a group of monkeys, you might not be able to count them all, so enter the minimum number you could count. In case of single observations enter "1".

Remarks: Here you will record any important notes you need to add to your observation.

The sheet below shows an example of how to fill the data recording sheet for the following scenario (compare also with the example given at the end of section 2.2 above to understand the main differences between the basic protocol and the Distance Sampling):

CF Site: Kortor CF — DISTANCE SAMPLING DATA SHEET — Data Recorder: Mary Prosper

Date: 28/03/2014	**Transect No:** T14	**Start Point:** 0m	**Start Time:** 07:52	**End Time:**

Fill this sheet for all direct encounters, dung and chimpanzee nests.
In case of clustered observations fill one row for each individual, but give all the same No.

No.	Time	Meter	Species	Type of sign	Distance (m. cm)	Age of sign	Group size	Remarks
1	08:18	150	Maxwell's Duiker	SEE	4.65	-	1	
2	10:15	550	Chimpanzee	NES	1.48	1	3	dung of age class 2 below the nest
2	10:15	550	Chimpanzee	NES	0.00	1	3	
2	10:15	550	Chimpanzee	NES	3.78	2	3	
3	11:08	600	Bay Duiker	DUN	1.22	3	1	
4	11:44	800	Elephant	DUN	0.45	3	5	
4	11:44	800	Elephant	DUN	0.88	3	5	
4	11:44	800	Elephant	DUN	2.34	2	5	
4	11:44	800	Elephant	DUN	1.79	3	5	
4	11:44	800	Elephant	DUN	3.04	2	5	
5	13:27	1150	Diana Monkey	SEE	14.70	-	7	
6	13:27	1150	Red Colobus Monkey	SEE	18.90	-	5	flee when they see us

- On the 28th of March 2014, the Field Team together with the Field Assistant Mary Prosper carry out the biomonitoring data collection along Transect No. 14 in the Kortor CF. Mary is responsible for the Distance Data recording.
- They start the survey from the starting point at 07:52.
- At 08:18, at approximately the 150m mark, they see a Maxwell Duiker on the left side of the transect. The animal immediately runs away, but the Team and Mary remember where it stood. They measure a perpendicular distance of 4.65 meter.
- At 10:15 they encounter a fresh chimpanzee nest, at a distance of 1.48m off the transect line. Under the nest they find some dung of age class 2, so Mary makes a note on that in the "Remarks" column. They carefully check the surrounding area and discover two more nests, one directly above the transect line (which corresponds to a distance of 0.00m), also age class 1, and another one of age class 2 at a perpendicular distance of 3.78 meter. Since the three nests are very close together, they very likely were built by chimpanzees of the same group and hence they form a cluster. Thus the three records receive all the same observation number, No. 2, and the group size is 3.
- At 11:08 they find Bay Duiker dung, age class 3, at a distance of 1.22 meter. The observation was made not far from the 600m mark.
- The next observation, which is recorded in the Distance Data Sheet, is elephant dung between the 800m and 850 m mark, at 11:44. The Team carefully checks the area and – also based on other indications such as tracks and roads – concludes that a group of elephants has roamed in that area, and identifies dung of five different individuals (at distances of 0.45m, 0.88m, 2.34m, 1.79m and 3.04m, respectively). The age class of the different piles was rated either 2 or 3. As in the case of the chimpanzee nests, this is a clustered observation, and each individual receives the same No. 4 (as it is the fourth observation along the transect).
- At 13:27, around 1,150 meter transect length, Mary and the Team see a group of Diana Monkeys, mixed with Red Colobus Monkeys. Since these are two different species and thus two different observations, they do not get the same, but separate observations numbers (No. 5 and No. 6, respectively). The Red Colobus Monkeys immediately flee as the field team appears, so they quickly have to decide where the group center point was at the initial contact. The same applies for the Diana Monkeys. The perpendicular distances were measured with a range finder at 14.70m, and 18.90m, respectively. The field team could count at least 7 Diana Monkeys, and 5 Red Colobus Monkeys.
- etc.

3.3 How to use the Range Finder

The Range Finder is a tool that helps you to measure distances which are too large to be measured with the tape measure. The model we are using (NIKON LASER 550) can measure from 10 m up to 500 m. It is working by emitting laser rays (see ***Caution*** note), which are reflected by the objective you want to measure. For your measurement you therefore have to select a reflecting target such as a tree stem, which aligns with the distance you want to measure.

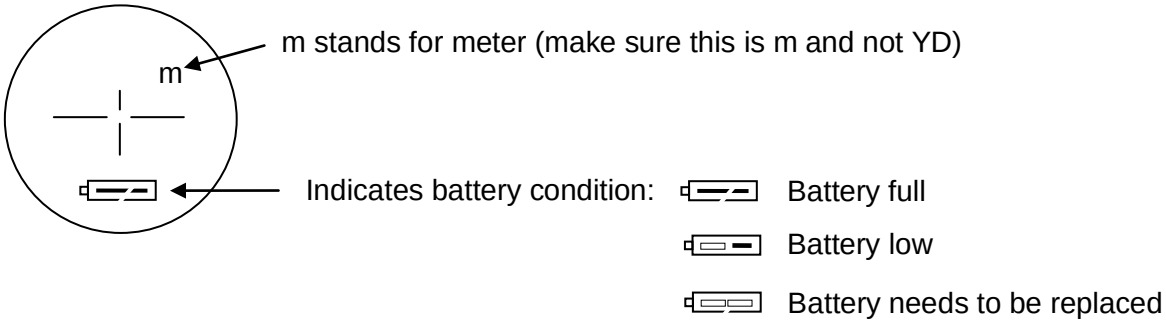
! ***Caution***: The Ranger Finder is working by emitting laser rays which are invisible but can damage your eye if you look directly into it. Therefore:

- Never look into the laser emitter while power is on
- Never aim at your or somebody's eyes

Overview:

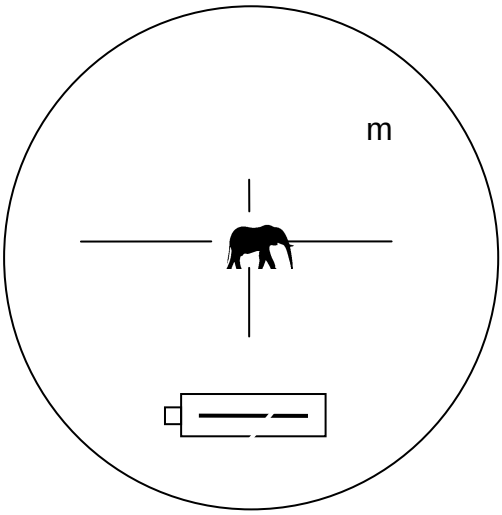
How to use it:

1. Press the Power Button (briefly, do not hold it) and look through the eyepiece. You will see the following display:



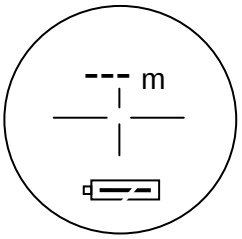
2. Make sure the display shows **m** (for meter), and not YD (yard), because we want to measure the distance in meter. In case there is YD, you have to change it to **m** (see below)

3. Aim at the target. Position the target (in the example below an elephant) in the center of the four lines:



4. Press the Power Button and hold it until the distance appears in the display (e.g. 26.5 m, see left figure below). In case the measurement was not succesful, you will see three bars in the display (right figure below). It means that the measurement was not possible, because the target object is too close or too far for the range finder; or the objective is not reflecting well. Try again with another target within the same distance

Measurement was successful



Measurement was not successful

<u>How to change from YD to m:</u>

1. Press the Power Button (briefly, do not hold it) and look through the eyepiece.
2. Press and hold the Mode Button more than two seconds, until the YD symbol has switched to m.
3. As soon as the YD symbol has switched to m, release the Mode Button. In the display should now appear m.

4. Important rules for accurate data collection

In the previous chapters you have learned a lot about the data collection methodology we are going to use for biomonitoring. The data we record along the transects will however only be useful if we work as accurately as possible. In this chapter we summarize the most important rules which have to be followed and which common mistakes we have to avoid.

Organization & implementation

- Make a good plan when / how to carry out your surveys and align it with the other teams. In the dry season the data collection should be carried out between November and April. Think about how many field trips you will need to survey all transects in your community forest. For example, in case there are 30 transects to be monitored, you could for example carry out 3 field surveys à 10 transects each, or 5 surveys à 6 transects each etc., whatever is most effective in terms of logistics and feasibility.

- If there are more field teams responsible for the monitoring of one forest, it is important that all teams carry out the surveys at the same time. This will allow the comparison of the data of the different zones. Thus the teams have to communicate and align their field survey plans. For example if the first survey phase is planned for November, then all teams should go around the same time (for example in the first half of the month).

- Four persons per team will carry out the data collection, while 2 stay in the camp for cooking and security. With regard to data reliability it is highly recommended that always the same persons do the data collection. 2 trackers should focus on the forest floor to find footprints, dung etc., while the other 2 should observe the canopy for animals, nests etc. in the trees.

Data collection along the transects

- Every part of a transect line must be surveyed. Sometimes the line will lead through Uapaca roots or across a big rock, but as long as you don't have an insurmountable object (for example such as a huge Ekki tree) you have to follow the line. Do not take detours because it's more convenient!

- No signs should be missed. Take time and walk the transect slowly, search carefully for animals and signs on the ground and in the canopy, to make sure that you don't miss anything.

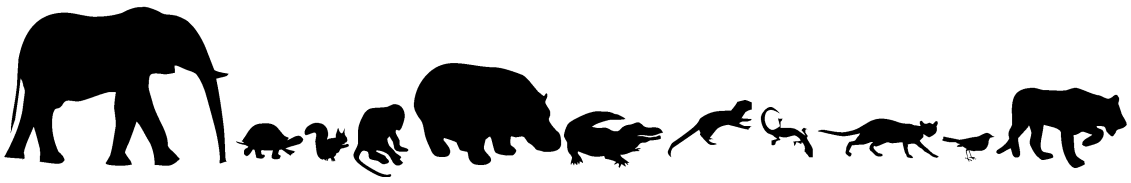
  Pay attention especially to the following situations:

  - Objects directly above your head are easily missed, so the 2 trackers focusing on the canopy must check regularly the area directly above them
  - Walking uphill/downhill: When you walk uphill your view and eye-level is more focused on the ground and you might easily miss objects in the canopy. When you walk downhill your view and eye-level is more focused on the canopy and therefore you might easily miss objects on the ground. So all trackers should regularly turn around and look back in order to check the whole range of vision.

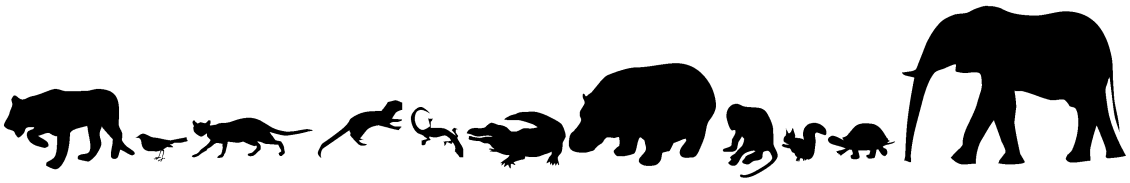
- Do not leave the line to follow animals or to record signs beyond your view. All observations must **first** be seen from the transect line. After you have spotted something, it is of course allowed to leave the line in order to get a better view, to take your measurements, etc. In the special case of chimpanzee nests, as soon as you have spotted a nest from the line, you are allowed or even should leave the line to find more nests.

- Accurate measurements are fundamental. In case of Distance Sampling particular pay attention to the following:
  - Record the **perpendicular** distance
  - Perpendicular distances are measured from the **center** of the transect line. Sight along the transect and estimate where the center line lies. Imagine it as a very thin line indicating the exact center of the cut passage
  - All measurements must be recorded as exact as possible. If we use the tape measure, the distance should be recorded to the nearest centimeter (e.g. 45 cm, 1.58 m; 8.65 m etc.). If we use the range finder, the distance must be recorded exactly as shown on the display.
  - Signs which are very close to the line must also be measured exactly, even if the distance is just a few centimeters (e.g. 3 cm), and not just recorded as 0 cm.

- Correct and reliable species identification is also essential. In case you are not sure of the species, you give the most accurate description that is possible (for example you see some monkeys, but they are too far away or disappear before you can identify them, you should just record “monkey”. If you are sure it must have been either Campbell’s or Spot-nosed monkeys, then you record “monkey” and make a note in the “Remark” column).



Good luck and successful monitoring!



U.S. Agency for International Development
Liberia Mission
502 Benson Street
Monrovia, Liberia