GUIDE TO GPS
FIELD DATA COLLECTION

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MAY 2008

POPS1406.1

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1.0 INTRODUCTION

The objective of this document is to provide a practical guide for conducting ground surveys or fieldwork associated with interpretation or classification of remote sensing imagery for biodiversity conservation; hereafter referred to as **field data survey**. The guide is based on experience gained collecting such data in several areas of the world for different applications, but focuses on field data survey conducted in Thua Thien-Hue Province with staff from several Provincial and National Departments and Institutes.

Specific aims of this document are:

- To provide basic principles for conducting field data surveys;
- Provide a general protocol for field data survey;
- Provide practical demonstration of field data survey planning, data collection, and processing; and
- Provide example remote sensing data and identify tools for working with the data.

This document does **not** provide details regarding statistical theory of sampling, geographical distribution of sampling, or details of how to address the issue of *spatial autocorrelation*. These issues are mentioned in the text, and references are provided if the reader desires more information.

2.0 BASIC PRINCIPLES OF GPS FIELD DATA SURVEYS

2.1 THE NEED FOR A GPS FIELD DATA SURVEY

Conducting a field data survey is based on a **need** for systematic data regarding the area that one wishes to investigate using satellite imagery. The user's needs may be as diverse as, the production of a thematic land cover map, understanding areas of land cover change, or simply to allow you to interpret the information presented in a satellite image.

Before undertaking a field data survey, it is important to determine the goals and objectives of the field program. If one knows an area very well, or have other sources of information available, e.g. recent aerial photographs, then one may not need to complete a field data survey. Surveys can be costly, so if other sources of information are available, this may reduce the need for a field data survey.

It is difficult to provide universal rules that can be followed for a field data survey, because the objective of the activity, landscape, area of interest, imagery used, all influence the way the survey should be conducted. However the type of information collected is not the same as in other disciplines, e.g. biodiversity or forestry assessments – such information is to be used specifically for the interpretation of satellite imagery.

2.2 SATELLITE IMAGERY

Before planning a field data survey, one must evaluate the satellite imagery that is available. A number of important questions to consider include:

1. What is the area of interest for the satellite image or map?

2. What spatial scale is desired? The size of the study area, the complexity of the landscape, and other issues will influence the type of imagery that is appropriate. Spatial resolution of imagery will influence the aim of the field data survey; for example, Landsat Thematic Mapper (TM) images (30 m pixel size) require survey of habitat features that are appropriate for the available resolution, whereas Ikonos images (1 m pixel size) may require identification of smaller landscape features such as individual houses, fields, plant communities or trees.

3. What types of imagery are available and what is the available budget to buy new imagery?

4. What is the season and year of available archive images; are they suitable for observing the features that are required for the objectives of the study?

Usually, some compromises will be made because of availability of imagery, software tools, resources for purchase and analysis of imagery, and resources for conducting the field data survey. A useful introduction to satellite imagery and

planning satellite imagery projects can be obtained from the Center for Biodiversity and Conservation (CBC) Remote Sensing and GIS lab, which is part of the American Museum of Natural History (AMNH):

http://geospatial.amnh.org/

2.3 FEATURE CLASSIFICATION SYSTEM

A feature classification system refers to the discrete thematic data types that are the aim of the mapping exercise. A well thought out and well-defined system is essential for any successful mapping exercise. Some important considerations are:

- Be realistic – the system must be appropriate for the imagery available and the capacity of the remote sensing data to discriminate those classes. Note that detailed ground-based classification systems for ecological or forestry disciplines are often unrealistic when working with satellite imagery, and if they are to be used they often require some form of aggregation; and

- Reduce ambiguity – the classification system must have clear definitions. During the ground survey, it should not be difficult to decide which classification a particular area belongs to, although there will always be complex transition zones between various classifications.

2.4 PLANNING A FIELD DATA SURVEY

If the need for a survey has been identified, and the satellite imagery, and other resources are available to conduct the proposed work, then detailed planning for the field data survey must be conducted. As part of identifying the need for a field data survey, existing topographic and vegetation maps and other spatial data should have been compiled and consulted in advance. These maps and data are essential tools for planning a field data survey. The requirements of the planning process will be specific to the project, but some general activities should be conducted include:

1. Assemble your proposed field data survey team – discuss ideas regarding locations that are important to study, and review the classification system;

2. Consult the available maps and satellite imagery – identify areas of particular interest or uncertainty with regard to information and land cover types in the satellite image;

3. It may be useful to complete an 'unsupervised classification' on available imagery in advance of the field data survey, in order to understand the potential distribution of land cover types and areas of uncertainty;

4. Determine the logistical requirements (e.g., boat, vehicle, helicopter, etc.) that are necessary to conduct the field data survey safely and efficiently;

5. Propose a route for the field data survey (e.g., by vehicle), estimate the number of days required, and locations for overnight stays;

6. In each area where fieldwork will be conducted, research the ground conditions if they are not known, for example whether access is by 4-wheel drive, motorbike, or on-foot;

7. Consult with local officials regarding your field survey plan, and take advice from people who know the area;

8. Always plan for delays and make sure you have a contingency plan if issues such as bad weather, access restrictions or injury cause delays during parts of your trip; and

9. Follow appropriate safety protocols for your fieldwork.

2.5 SAMPLING FREQUENCY AND DISTRIBUTION

There are no strict rules related to sampling frequency and distribution of samples. Properties of landscape (in terms of topography and variation in land cover) mean that the requirements of field data surveys are often specific to the area of interest. In a complex and mountainous landscape, the land cover and topography may change over short distances, allowing the collection of information on different land cover types over smaller areas. In contrast, much larger distances may need to be covered to assess different land cover types in more homogenous areas, for example, large areas of grassland.

The survey should aim to record multiple observations of land cover types for each of the classes identified in the classification system. Rare land cover classes might be less frequently observed, but may require a special effort in order to improve confidence in the satellite imagery interpretation. A review of sampling considerations is provided by Lillesand and Kiefer (1994).

It is important to remember the objective of the field data survey, is related to the **interpretation of satellite imagery.** In general, this means that you should aim to survey a range of locations within your overall area of interest and collect 'well-spaced' observations in those areas. With geographic sampling, the issue of *spatial autocorrelation* when is important – two observations quite close to each other (e.g., in the same patch of forest) cannot be considered independent, which is a requirement for certain statistical analysis. A general rule is to record observations when moving into new areas, or when you have moved into a new landscape area (e.g. new slope aspect, new valley, etc.).

2.6 SURVEY EQUIPMENT

There are many general equipment requirements for fieldwork, e.g. those related to general safety and navigation. A field data survey requires additional equipment, examples of which are given in Section 1.0, these include:

- A well-designed *data collection form* – this can improve the accuracy and efficiency of fieldwork, and can also make computer data entry easier;
- Global Positioning System (GPS) – there are a variety of handheld GPS units that are available that allow the user to save each observation position (waypoint), which can be exported later to a file for processing once the fieldwork is complete;
- Digital Camera – with high picture resolution, e.g. at least 3.2 mega-pixel, preferably with a date and time stamp;
- Compass – to record the bearing of each photograph (optional);
- Wrist watch – to record the time of observations, which can be cross-referenced with the GPS waypoint and photograph acquisition time; and
- Imagery and/or maps – it is helpful to have printouts of imagery during the fieldwork in order to identify areas of particular interest in the imagery; if possible, they should be laminated to protect them from the elements.

2.7 REQUIREMENTS FOLLOWING A SURVEY

Following a survey, careful compilation of data is required. Specific activities depend on the type of GPS, spreadsheet software and GIS software available; however, there are some general rules, as follows:

- Compile the data as soon as possible, while the field experience is 'fresh' in the memory;
- Provide metadata, or descriptions of all files and folders, when you compile the data;
- Always keep the original GPS data and photographs – don't delete them! and;
- Back-up all the data to a CD and label it appropriately.

3.0 PROTOCOL FOR FIELD DATA SURVEY

It is very important to establish a protocol for the field data survey; each team member must understand their role, and adhere to the protocol. The following sections describe the protocol followed during the field data survey, and provide some suggestions when conducting field data surveys.

3.1 EQUIPMENT SETUP

GPS:

- Take one, or preferably two, GPS units to the field;
- Make sure you know how to use the GPS – read the instructions;
- Set up the GPS with the appropriate coordinate system for your mapping work;
- Check the memory and download and archive any waypoints that remain in memory;
- Take spare batteries – do not buy low quality batteries! and
- Set up the GPS to store tracks – make sure you have enough memory to store the total number of track points from your survey. Adjust the time interval between track points based on the estimated time in the field, and the amount of memory, to ensure tracks do not get over-written.

Camera:

- Make sure your camera has sufficient memory to store up to several hundred high quality photographs;
- Synchronize the camera date and time with the GPS;
- Set the camera picture quality to its highest resolution;
- Take spare batteries – do not buy low quality batteries! and
- Take a back-up camera and additional memory (if possible), in the event of technical problems.

Data collection form:

- Print sufficient data collection forms;
- Use water resistant paper, if possible (e.g. 'Rite In the Rain');
- Write with a pencil; and
- Bring copies of field maps, laminated if possible.

3.2 DATA COLLECTION FORM

The data collection form was developed using an Excel spreadsheet; see Appendix A1 for a copy of the form. The form has fields for collection of general information and waypoint information. The form fields are defined below and the protocol for completion of each form is described in Section 3.3.

3.2.1 General Information

The following information should be recorded at the start of each survey day and on each data collection sheet:

- **Page #** - if multiple pages are needed, record the page sequence;
- **Date** – the date of the survey;
- **GPS Model** – the ID of the GPS used, which may be important if several GPS units are used;
- **Camera Model** – the ID of the camera used, which may be important if a department or organization has several cameras used for surveys;
- **Notes Taken By** – the name of the person recording the field notes;
- **Team Members** – the names of all members of the survey team;
- **GPS Co-ordinate System** – the projection, datum, and co-ordinate system used for the field data collection;
- **GPS Time Zone –** the time zone that the GPS has been configured to; and
- **GPS, Camera and Wristwatch Synchronized** – note if all electronic equipment has been synchronized to a common timestamp.

3.2.2 Waypoint Information

The following describes information that should be recorded when waypoints are collected:

- **GPS Waypoint Name** – the waypoint name or number for the GPS used (i.e. 001, 002, 003, etc.);
- **Photo Number** – the number of the photo taken;
- **Photo Time** – time the photo was taken in hours and minutes, synchronized with the GPS (i.e. hh:mm);
- **Photo Bearing** – photo bearing in degrees (i.e. 0 to 360°) in the direction of the object being described;

- **GPS Time** – time in hours, minutes, seconds recorded from the GPS (i.e., hh:mm:ss);

- **Waypoint GPS Coordinates** – the coordinates of the waypoint;

- **Description** – additional description of the land cover, including the name of other classes recorded in the vicinity (e.g. plantation) or context information; and

- **Sketch Box** – additional information on surrounding features can be schematically drawn.

3.3 DATA RECORDING PROTOCOL

The data collection form should make information collection straightforward and reduce uncertainty and errors in data recording. The continuous recording of tracks allows the survey team to re-trace the entire field collection route, which could be useful when interpreting the satellite imagery. Individual waypoints are collected at locations of a specific land class or area of interest. Below are some basic steps to follow, which will improve the ability to use the field data collected:

1. Preparation:

    - Create a new GPS track at the start of the day. Make sure that the maximum number of tracks is high enough so that the whole day can be tracked at the desired observation frequency (e.g. 15 second track intervals for 8 hours requires capacity for 1,920 tracks);

    - Record the **Page #**, **Date**, **GPS Model**, **Camera Model**, **Notes Taken By**, **Team Members**, **GPS Co-ordinate System**, **GPS Time Zone**, and **GPS, Camera and Wristwatch Synchronized** notes at the top of <u>every</u> data collection form;

    - Check that the wristwatch date and time are correct, and synchronized to the GPS;

    - Check that the camera date and time are correct, and synchronized to the GPS; and

    - Check that the camera is set to take maximum resolution photographs.

2. Data Collection at a waypoint location:

    - Record a **waypoint** at each survey location and record the GPS waypoint number;
    - Record GPS time;
    - Record photo time. If more than one photo is acquired, use a **new row** on the data collection form for each photo, and record the new time for each photo;
    - Record the bearing of each photo;
    - When recording data, complete a new row for each waypoint, or photo;
    - Record the Waypoint GPS coordinates; and
    - Include a brief description of what is located at the waypoint;

3. Using a hard copy map:

    - At each waypoint, if you have a large scale topographic map or image, you may wish to record your route (track) and each waypoint on the map in an approximate position, for example using the GPS coordinates; and
    - Also, you may wish to mark on the map the feature that you were describing, especially if this feature was on a facing slope of a valley. This will aid the interpretation of the photographs, and bearing information recorded on the field data sheet.

4. Follow up:

    - At the end of the day, review the collected information to make sure it is clear and all information required was recorded; and
    - If possible, download the GPS tracks, waypoints, and photographs to a computer.

The above steps describe the protocol for the collection of field data using a manual technique. Data collection and attributing can also be captured digitally, using Personal Digital Assistant (PDA) devices and specialized software. This will be discussed further in Section **Error! Reference source not found.**.

4.0 PROCESSING OF FIELD DATA

The processing of collected data will vary according to the type of GPS unit and the software packages available.

4.1 DOWNLOADING GPS DATA

Useful free software for working with GPS data includes *GPSTrackMaker,* which was developed by Odilon Ferreira Junior (www.gpstm.com); another popular free package is *OziExplorer* (www.oziexplorer.com). Depending on your model of GPS, it may be better to use the software that comes with your GPS unit (e.g. *Garmin Mapsource*). It is also useful to note that ArcMap v9 offers GPS support that allows for the direct connection to a GPS unit and real-time data collection and digitizing.

The following are guidelines for processing GPS waypoint data:

1. Create a folder called GPS_Data;

2. In a sub-folder (e.g. Raw), store the GPS data in its raw or native format;

3. In a sub-folder (e.g. Excel), use GPS software to save the **Waypoints** and **Tracks** as comma delimited text files. Or by using Excel, save the files as a *.xls files (**Tracks.xls, waypoints.xls**).

   - Waypoints.xls should have the following fields: WpN, X, Y, GPSUnit, Date, Time, and Elev.

   - Tracks.xls will have x, y, GPSunit, date, time, and elevation fields, but unfortunately some GPS software tools do not import the time, date and elevation data for tracks.

4.2 FIELD DATA ENTRY

Data should be transferred from the data collection forms into an Excel spreadsheet manually, as follows:

1. Create a folder called Survey_Data;

2. Create an Excel file called **SurveyData.xls**, which will be a template for data transfer from the data collection forms. A sample spreadsheet is provided in Appendix A2.

   - **SurveyData.xls** will have the following fields: Date, GPSUnit, Camera, WpN, GPSTime, PhotoTime, Bearing, Distance, Class, and Description.

   - WpN needs to contain unique values (primary key). If you have two waypoints with the same number, then create a suffix to the waypoint, e.g., a001, b001, where “a” and “b” are the GPSUnit.

4.3 PHOTOGRAPHS

A crucial process is providing the correct basis to link the photographs taken to the collected waypoints.

1. Download the photographs from the camera into a folder called Photos;

   Modify and rotate the photos as required. Note that this will reset the Date Modified for the photo, which should be **reset to the date and time that the photo was taken** (the EXIF date). Useful software to use is *Thumbplus* (www.cerious.com), which has a free 30-day trial;

   Create a text file called **PhotoCatalog.txt** containing a list of the all the individual photo file names and their directory path. This can be completed in a number of ways, for example using MS Outlook;

   a. Select '*Advanced Find*' from the '*Tools*' menu and select '*Files*' from the '*Look for*' drop down list box and *select* '*All Files (*.*)*' from the '*Of type*' drop down list box;

   b. Click on '*Browse*' and navigate to the directory containing all field photos taken from field data survey, and click on '*Find Now*';

   c. The search results will be listed at the bottom of the '*Advanced Find*' dialog box and will have both the file names and their directory path; and

   d. Select all results and copy/paste them in an Excel spreadsheet for further manipulation and sorting;

   Create an Excel file called **PhotoCatalog.xls**, which has the following fields:

   2. WpN, PhotoName, Path, and DateTime; and

   3. Create an additional field called "Hyperlink" or "Path", which has the full file path and name (e.g., C:/myfielddata/photos/photo1234.jpg);

   The Final stage is to enter the waypoint number for each photo, matching the **Date and Time** of the Photo and those from **SurveyData.xls.** A separate field should be created containing the waypoint.

See photo catalogue in Appendix A3 for an example of the result of these steps.

5.0 THE NEXT STEP

Once all the field data has been entered, the next step will be to create GIS data. This will include the creation of shape files containing the recorded waypoints and tracks. Once created, attributes can be appended to the shape files. Attributes can include additional typed information or, if required, hyperlinked photographs.

The creation of GIS data will be covered in subsequent training material.

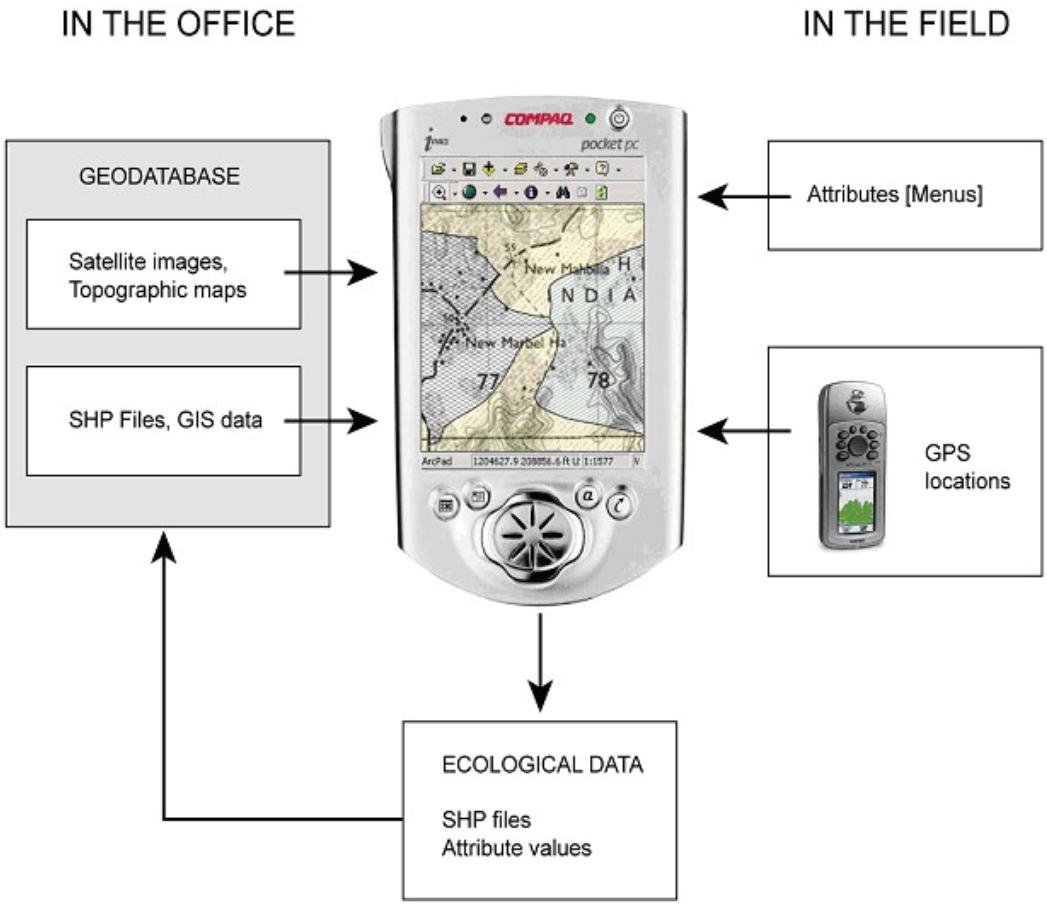
6.0 FUTURE TECHNOLOGIES

Data collection and real-time information gathering and digitizing can now be effectively done digitally using PDA devices and specialized software. ESRI ArcPAD, for example, provides support for industry standard vector and raster image display and allows for the use of satellite images (in combination with other GIS layers) in the field, as a base to collect information. The interface with the GPS allows for real-time navigation and recording of geographic locations.

There are many other software packages available for real-time data collection that can be used on PDA devices or laptop tablets. A few are *OziExplorerCE*, *VITO SmartMap*, and *Virtual Earth Mobile (VEM)*.

Using such tools, most steps described in this report could be completed in the field, reducing the amount of time for data management, preparation, and post-data collection processing.

Figure 1 Data collection using integrated PDA and GPS devices.



7.0 FURTHER INFORMATION AND REFERENCES

For more information on field data survey, GPS and mapping ideas, remote sensing, see the following sources of information:

- **Remote Sensing and GIS Lab,** Center of the Biodiversity and Conservation, **American Museum of Natural History**. The Remote Sensing and GIS lab is a leader in developing and promoting the effective use of geospatial tools by amateur and professional conservation practitioners – see http://geospatial.amnh.org/.

- Lillesand, T.M. and Kiefer, R.W. (1994) **Remote Sensing and Image Interpretation**, John Wiley and Sons, Inc, - this book provides a great introduction to Remote Sensing, including some information on surveying and sampling.

- **Mapping Hacks** by Erle, Gibson and Walsh (2005), O'Reilly Media, Inc. There are many ways and techniques used in mapping GPS data. For interesting and fun techniques in mapping your GPS waypoints and tracks, as well as geo-referencing digital photos, **Mapping Hacks** has some great ideas. For more information please refer to http://mappinghacks.com/.